

Missouri Technology Plan

Preface

As Missouri faces the challenges of this century and the new economy, it must decide on the best uses of its finite funding to create wealth for Missouri businesses and citizens. The success of Silicon Valley and other internationally recognized technology corridors provides ample evidence to the wisdom of supporting technology development. Evidence suggests a full-scope plan must address the types of technology to be targeted, the funding necessary to develop critical mass in these technologies, and required skills of a technology-based workforce.

This report represents a compilation of recommendations made by influential and knowledgeable representatives in each of these areas. If followed, these recommendations will lead to Missouri's leadership in life sciences, information technology, and advanced manufacturing of transportation equipment.

A summary of all recommendations is found near the end of this report. The reader will also note that many of these recommendations appear in the relevant sections, and are often repeated between sections. These sections will provide deeper insight into the justification for these recommendations.

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Executive Summary

Missouri is at an important crossroads in determining its economic future. If Missouri is going to share in the wealth created by a global technology-driven economy, it must make the commitment to fully develop the necessary resources. If we fail to do this, we will fall into the ranks of second-class states that only provide ancillary support to the primary technology industries in other states.

Missouri would feed on the crumbs that drop from the table by providing goods and services from spin-off economic impact, rather than being a regional or national hub for economic growth. An accurate analogy would be the “bedroom communities” that feed off the economic engines of cities, without any primary, independent wealth creation industries and businesses of their own.

Missouri’s technology plan must capitalize on existing strengths and areas of strong potential. After extensive study of existing resources and business activity, it has been determined that Missouri has the necessary critical mass to become a national leader in industries built around three key technologies: life sciences, information technology, and advanced manufacturing of transportation equipment. These three industrial clusters directly or indirectly make up more than 24.3 percent of Missouri’s gross state product, and employ over 550,000 Missourians.

Life Sciences are already well represented in Missouri. A substantial critical mass of industries, researchers, and universities exists in this growing industrial cluster, which is expected to rival the computer industry in importance and economic impact during this century. A good Missouri life sciences foundation is found along specific corridors in the state.

- Plant sciences—St. Louis, Columbia, Southeast Missouri
- Human health sciences—St. Louis, Kansas City, Columbia, Kirksville
- Environmental sciences—Rolla-Ft. Leonard Wood, Springfield

To help encourage the development of the life sciences industry in Missouri, the state must support three distinct objectives:

- Develop creative and appropriate financing avenues for start-up and small companies. Possible actions include targeted tax credits, expanded support for incubators and innovation centers, pre-seed and seed capital funding initiatives, dedication of a portion of the tobacco settlement funds to life sciences research and development.
- Promote technology transfer. This would be enhanced if the state would create incentives to encourage university researchers to engage in converting their life sciences research into commercial life sciences technologies and products.
- Enhance workforce education. State government’s role should be to provide incentives to companies to pay for continuing education of workers in life sciences fields, offer financial support to students entering and completing life sciences degree programs, and encourage a stronger emphasis on life sciences education at the elementary and secondary school levels.

Information technology (IT) is critical to Missouri as both an industrial cluster and an enabling technology. Life sciences, manufacturing, education, and most businesses are dependent upon IT. There are three keys to a successful IT state economic development strategy: connectivity, commerce, and competitive workforce.

Connectivity to high-speed and advanced telecommunications is a prerequisite to meeting the competition for markets in the modern networked economy. Unfortunately, the necessary high-speed and advanced telecommunications services are unavailable in two-thirds of Missouri, mostly in rural areas. This serious threat must be addressed by a comprehensive statewide telecommunications plan.

Most large businesses have already begun the process of adapting to the Internet, but an estimated 80 percent of Missouri's smaller businesses have delayed doing business in this profitable electronic realm. This is due to a lack of knowledge regarding cost/benefits and a need for technical assistance. State government can take action to accelerate the use and integration of Internet technologies by Missouri's manufacturing, service, and technology companies by establishing the Missouri eBusiness Institute (MO-eBI).

To fill the growing IT labor market, Missouri must establish IT training projects as a priority for customized training funds; encourage IT research universities in the state to expand research and development activities; and conduct further studies to improve our knowledge of the education and training needs of the IT industry and workforce.

Advanced manufacturing concepts and techniques are the keys for Missouri to enhance its national stature in the transportation industry. The following objectives are important to a statewide plan addressing this key to growth.

- Modernize technology and business practices.
- Establish market-driven incentives to encourage the development and application of innovations created from university research and state innovation center clients.
- Accelerate the use of advanced technologies and manufacturing practices by small and medium sized manufacturers through one statewide Manufacturing Extension Partnership program.
- Enhance the ability of engineers to identify and apply new technologies and innovations.
- Transform manufacturers into high performance work organizations by overcoming the severe shortage of skilled workers and managers through increased funding for an expanded customized training program.
- Expand Internet high-speed connectivity in rural areas to allow industries in these areas to conduct Business-to-Business and Business-to-Consumer electronic commerce.

The vital contribution of the state's colleges and universities can be enhanced by establishing cross-functional, integrated centers to support transportation equipment advanced manufacturing through education curriculum, workforce training, support of industry advisory boards, and applied research. Missouri can stimulate more industry/university research collaboration by targeting tax credits and leveraging increased industrial support with state matching funds. Tax incentives can be implemented to encourage industries to replace older equipment with more efficient, modern machinery.

Four Elements of Success

Ancient peoples tried to understand their world in terms of four elements: earth, wind, fire, and water. Missouri's Technology Plan depends on understanding and promoting four new elements to have success in the new economy and create wealth for our state.

- 1. Technology** Technology is the engine driving the new economy and the wealth it creates. Missouri government must support programs that provide the technology infrastructure needed for Missouri companies to grow. This includes allocation of general revenue funds, support of federal R&D, and dedicated state technology organizations.
- 2. People** Companies with highly trained workers will be the successful companies in the twenty-first century. To ensure the necessary supply of these workers, Missouri must continue to emphasize the improvement of math and science skills in our

education system, along with increased access to continuing technology training for working adults.

3. Money

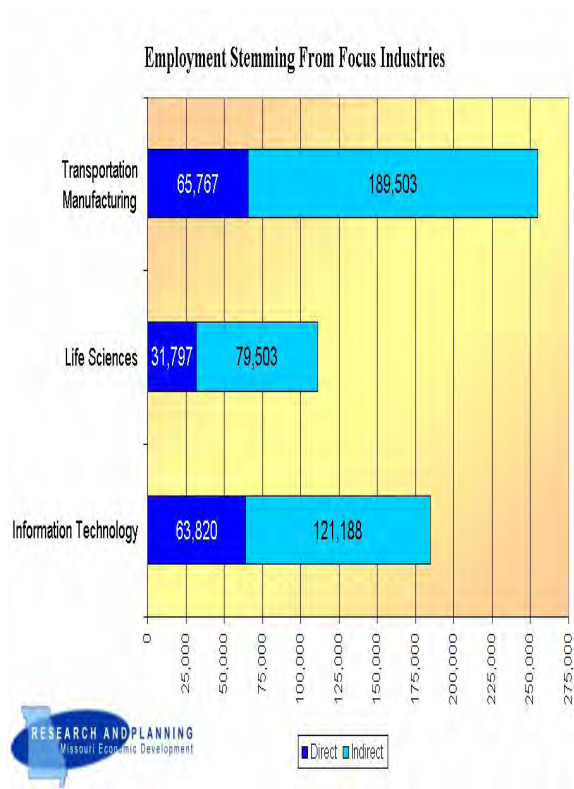
New products based on science and technology require increased resources to fund research and development as well as startup and manufacturing costs. Because of the complexity of these products, it can take many years and dollars before a product comes to market. We must ensure that Missouri companies have access to the capital resources needed to start and grow their operations.

4. Speed

Missouri government must move quickly to promote the facilitation of technology transfer to ensure that research is applied to the marketplace in a timely and efficient manner. Otherwise, research slow to develop will be worthless.

Ominous signs are on the horizon. Missouri companies that were formerly national and international leaders are being purchased, downsized, or moving their headquarters out of the state. Recent examples include McDonnell Douglas, Monsanto, Southwestern Bell, Purina, and TWA.

The good news is that these companies left a legacy of quality workers, technology development, and spin-off businesses that can anchor a technology comeback for our state and launch Missouri Fortune 500 companies of the future. The critical mass is here. Missouri can, and will, become an international leader in key industrial clusters, if it makes the necessary investment. That investment and the state's technology strategy should be managed and directed by a new Missouri Office of Science and Technology (MOST). This will assure that the state gets the MOST return on its investment in terms of a prosperous economy and prosperous citizens.



Life Sciences

What are the Life Sciences?

At the most basic level, life sciences encompass the study of all aspects of living organisms. In practical terms with respect to business and the economy, life sciences is the development and use of knowledge-based innovations for the improvement of plant and animal agriculture, enhancement of human and animal health and nutrition, and preservation and remediation of the environment.

Why Should Life Sciences be a Target Industry for Missouri?

Missouri can justify investing in life sciences based on the industry's demonstrated growth over the past decade and its recognized potential for truly astounding future growth. Successful development of life sciences as a targeted industry will result in the generation of high paying, desirable jobs for Missouri citizens and a significant and sustainable revenue source for state and local governments. The life science industry in Missouri accounts for:

- 2.5% of the Gross State Product directly, and generates an additional 2.5% indirectly.
- 111,000 Life Sciences related jobs in Missouri in 1999
- The creation of 100 jobs in the Life Sciences sector would produce \$???? In wages statewide, resulting in an average wage per job of \$????

Life science is a global growth industry that could potentially equal the computer industry in its economic impact. The biotechnology industry, which is the undisputed life sciences "star," for all practical purposes, did not exist prior to 1980. After a slow start, the industry began to gain momentum, doubling in size between 1993 and 1999. In May 2000, Ernst & Young published a report prepared for the Biotechnology Industry Organization entitled *The Economic Contributions of the Biotechnology Industry to the U.S. Economy*. The report states that sales of U.S. biotech products reached \$20 billion in 1999, and U.S. biotech companies directly accounted for over 150,000 jobs.

States whose institutions have strong life sciences research programs and effectively support technology transfer into the private sector find themselves in a very enviable position. They have fostered more start-up companies, have a more abundant supply of the highly skilled workers demanded by the life sciences industry, and ultimately more wealth generated for the state and its citizens.

Biotechnology and life sciences start-up companies usually operate at a loss over a period of several years while developing their technologies. During this period there is often little or no conventional income. Additionally, these companies often must acquire specialized and expensive equipment for use in their research programs and conduct lengthy and costly studies or clinical trials before a product can be brought to market.

It has been said that the 19th century was the Age of Chemistry, the 20th century was the Age of Physics, and the 21st century will be the Age of Biology. By many accounts, we are in the early stages of a biological revolution of a magnitude not experienced since the Industrial Revolution more than 200 years ago. Missouri cannot afford to wait until biotechnology "showcases" its value before instituting a strategy of its own to develop a biotechnology/life sciences industry. Life science is one of the great growth industries of our time, and Missourians deserve an opportunity to share in the wealth this industry is destined to create.

Life Sciences in Missouri Today

Life Sciences are well represented in Missouri. A substantial critical mass of industries, researchers, and universities presently exists in three distinct areas of life science:

- Plant sciences—St. Louis, Columbia, Southeast Missouri
- Human health sciences—St. Louis, Kansas City, Columbia, Kirksville
- Environmental sciences—Rolla-Ft. Leonard Wood, Springfield

Missouri's life sciences industry can be viewed in terms of clusters, defined as interwoven sets of assets that complement each other and drive the development of an industry. Such clusters include a strong bioscience academic and entrepreneurial environment, an adequate supply of capital, highly skilled workforce, and readily available business support services.

Four life sciences clusters are in varying stages of development in Missouri: St. Louis, Columbia, Kansas City and Rolla/Ft. Leonard Wood/Springfield. Less organized clusters with good potential exist in Kirksville and Cape Girardeau for health sciences, agriculture, and environmental sciences.

St. Louis

St. Louis has developed the most extensive life sciences cluster in Missouri to date. It enjoys the added advantage of being diversified across two major disciplines: plant science and human health. The Battelle Memorial Institute recently completed a comprehensive strategic plan for this cluster. This plan identified regional strengths in the following topical areas.

Plant sciences	Genomics and gene sequencing
Tropical botany	Neuroscience
Virology/Microbiology/Immunology	Cardiology
Biomedical engineering	

St. Louis Key Public and Private Resources for Life Sciences Industry:

Donald Danforth Plant Science Center	Monsanto
Washington University Biology Department	Washington Univ. Genome Sequencing Center
Washington University Medical School	WU Dept. of Biomedical Engineering
Future WU Comprehensive Cancer Center	Saint Louis University
SLU Vaccine Clinical Trial Center	Sigma-Aldrich
University of Missouri-St. Louis	Center for Emerging Technologies
Nidus Center for Scientific Enterprise	Barnes-Jewish Hospital
Missouri Botanical Garden	Technopolis St. Louis
St. Louis County Enterprise Center	St. Charles Synergy Center
SLU Center for Study of Bioterrorism and Emerging Infectious Diseases	Missouri Research Park

The amount of investment already made in life sciences in the St. Louis cluster is considerable. The initial funding for the Donald Danforth Plant Science Center exceeded \$140 million. The Nidus Center and the Center for Emerging Technologies together will soon raise close to \$25 million in capital. The five academic research institutions in the St. Louis cluster had a combined R&D expenditure total of \$362 million for fiscal year 1998. Washington University and Saint Louis University are both major recipients of federal funding for medical research programs, with Washington University receiving \$235 million for various life sciences programs in FY98 and Saint Louis University receiving a \$25.5 million grant for research into new and improved vaccines, among other programs. The Missouri Research Park and tenant firms represent total investment of \$175 million to date with \$36 million of that directly for life sciences.

Columbia

Columbia represents a major life sciences cluster both from its geographic position midway between the St. Louis and Kansas City life sciences clusters, and as the home of the main campus of the University of Missouri (MU). The interdisciplinary approach prevalent at MU, particularly between the biochemical engineering and agronomy departments, create a powerful interface for developing life sciences technology in the “plants-as-factories” approach. The university was recently awarded a NSF grant for \$11 million for its part in the maize genome mapping project. As one of a three-university consortium, MU will be helping to develop the maize genome database. The university’s life sciences research activities are enhanced by its partnership with the Donald Danforth Plant Science Center in St. Louis.

Columbia Key Public and Private Resources for Life Sciences Industry:

UMC Molecular Biology Program	Maize Genome Mapping Project
Missouri Innovation Center	UMC Research Nuclear Reactor
UMC Veterinary Diagnostic Laboratory	College of Agriculture, Food, & Natural Resources
UMC School of Medicine	

The University of Missouri has targeted \$80 million for life sciences investments, \$50 million of which is to be directed toward the construction of the new Life Sciences Center. In concert with the life sciences initiative, the university is also undertaking to establish an on-campus business incubator to facilitate the transfer of life sciences technology from these life sciences and other research area resources.

In addition, the university has announced plans to build a \$1 billion Cancer Treatment Research Center to operate in conjunction with the MU campus. This project was enhanced by recent research grants, including a three-year, \$261,000 grant from the American Cancer Society, a \$900,000 grant from the National Institutes of Health (NIH) for an 11-year study, and a grant for \$300,000 from the National Science Foundation (NSF) for studies of tumor-promoting molecules.

Kansas City

The Kansas City metropolitan region is emerging as a center for human health research. The Life Sciences Task Force was formed to review the area’s assets at length and determine an appropriate strategy for developing them into a viable life sciences cluster. Out of this review has grown the Kansas City Area Life Sciences Institute, an organization that is charged with the mission to ensure the implementation of the community’s life sciences strategy. The Institute’s objective is to play an oversight role in ensuring that area fundraising and lobbying efforts remain focused on the development of the Kansas City life sciences cluster.

The Kansas City region has identified five major areas of focus for its life sciences cluster.

Neurological diseases	Cardiovascular diseases
Infectious diseases	Cancer
Human development and aging	

Six primary research and development disciplines were identified as being critical to the focus areas.

Cell/molecular biology	Clinical services
Pharmacology	Behavioral sciences
Immunology	Genetics

Kansas City Key Public and Private Resources for Life Sciences Industry:

Stowers Institute for Medical Research	UMKC School of Medicine
KU Medical Center-Kansas City	Midwest Research Institute
Truman Medical Center	Children’s Hospital
St. Luke’s Medical Center	Brush Creek Enterprise Center
Kauffman Foundation	

The region plans to raise \$300 million in community-generated funds over the next ten years as a catalyst to initiate increased R&D investments. The goal for the \$30 million annual investment is to jumpstart annual research and development spending in the region to the \$500 million level, representing a 14:1 return on investment for the community. Kansas City is also placing special emphasis on life sciences education, including the K-12 years.

Rolla-Ft. Leonard Wood-Springfield

The unique geographic location of the Rolla-Ft. Leonard Wood-Springfield region and a wondrous array of natural and recreational resources contribute to a natural momentum for the region to develop as a major center for environmental research and technology development. While much basic research in environmental and life sciences is taking place in this corridor, the real strength of the area is found in its engineering expertise for actual application of new technologies.

Anchoring the research and development assets in this geographic region are the University of Missouri-Rolla, the U.S. Army's Maneuver Support Center at Ft. Leonard Wood, the Missouri Enterprise Business Assistance Center, and Southwest Missouri State University at Springfield.

University of Missouri-Rolla

UMR programs aimed at understanding and treating human diseases focus heavily on treatments for cancer. On the environmental science front, UMR is actively engaged in conducting bio-related research in areas that traditionally have been considered largely the province of mechanical or chemical engineering.

Rolla Key Public and Private Resources for Life Sciences Industry:

UMR Center for Environmental Science & Technology	UMR Cloud and Aerosol Science Lab
UMR Environmental Trace Substances Laboratory	UMR Environmental Research Center
Missouri Enterprise Business Assistance Center	UMR Materials Research Center
DNR Division of Geology and Land Survey	USGS Mid-Continent Mapping Center
Mark Twain National Forest Headquarters	Value-Added Ag Cooperative Assistance

Ft. Leonard Wood

Ft. Leonard Wood (FLW) provides unique opportunities for environmental life sciences efforts in Missouri and is a good complement to the work ongoing at the University of Missouri-Rolla. It is home to the U.S. Army Maneuver Support Center (MANSCEN) that is charged with conducting environmental stewardship training throughout the armed forces. It is also a major center for research, development, testing, and evaluation activities for new chemical, engineering, and non-lethal technologies. FLW is, also, a good entry point to network with other government agencies with synergistic concerns and solutions.

Over \$240 million has been spent at Fort Leonard Wood to house the Army's engineering, chemical defense, and military police schools. This move and the assignment of additional missions have resulted in a number of activities with environmental science implications. Another \$290 million in new construction is underway or planned in the next two years to enhance the installation's capability to support new and expanded missions created by future Department of Defense reorganizations.

The University of Missouri has entered into a long-term lease with the Army to develop and operate a 62 acre Technology Park at FLW in cooperation with the Missouri Department of Economic Development. This park is expected to attract commercial and academic tenants who are involved in one or more of the many technology areas related to MANSCEN. The state legislature and the University of Missouri are funding development costs. This development will help hedge against the closing of FLW in future Base

Realignment and Closure (BRAC) initiatives, which would reduce the Gross State Product of Missouri by \$897 million a year.

Fort Leonard Wood Key Resources for Life Sciences Industry:

U.S. Army Environmental Training Center	Countermine Training and Testing Facility
National Humanitarian De-mining Center	Center of Excellence for Homeland Security
Weapons of Mass Destruction Civil Support Team	Chemical Detection Training Facility
Army Radiological Laboratory	University of Missouri Technology Park
Army Maneuver Support Battle Laboratory	Army Terrain Visualization Center
Army Robotics Technology Insertion Activity	

Springfield

While Southwest Missouri State University and Springfield are major service areas for medical technologies and health care delivery, research is heavily directed toward the environmental sciences.

Springfield Area Key Resources for Life Sciences Industry:

SMSU Geology Department	SMSU Bull Shoals Field Station
SMSU State Fruit Experiment Station	Midwest Viticulture and Enology Center
Cox Medical Centers	St. John's Medical Centers
Federal Prison Medical Center	

Kirksville

Kirksville is home to Truman State University and the Kirksville College of Osteopathic Medicine (KCOM), which has developed five strategic initiatives for life sciences research and development. The following programs represent the five strategic initiatives: 1) osteopathic research, 2) wellness promotion, 3) senior healthcare, 4) health device evaluation, and 5) international outreach.

Cape Girardeau and Southeast Missouri

Southeast Missouri State University

Southeast Missouri State University (SEMO) at Cape Girardeau has organized a number of life sciences disciplines under the aegis of the College of Science and Technology. Research programs at SEMO encompass molecular biology, work on proteins, bioremediation, and the use of molecular modeling in designing synthesis and ligand and steric effects on the stability of molecules. Major opportunities in the life sciences exist for SEMO, particularly in the areas of agriculture (specialty/identity-preserved crops), and environmental sciences (river use, reforestation, land management.)

Delta Research Center

The Delta Research Center supports and facilitates the overall research program of the Missouri Agricultural Experiment Station. The goals of this agency include enhancing the natural resource base, supporting a vital food and fiber system, and contributing to the productivity of Missouri agricultural producers. Of particular interest for the agricultural life sciences cluster are the long-term experiments at the Delta Research Center to characterize and quantify the soybean cyst nematode problem worldwide.

Life Sciences in Missouri Tomorrow

After designating life sciences as a lead industry, the state in 1999 began an initiative to evaluate the current status of life sciences within its borders. A part of this initiative was to begin formulating a three-prong strategy to increase life sciences presence in Missouri.

- Encourage new life sciences businesses to form
- Attract out-of-state life science companies to relocate to Missouri
- Ensure that life science companies already here receive the support they need to stay and grow

Missouri's Four Elements of Success

- **Technology**
Build on the technology infrastructure throughout the state by increasing support for technology programs, incubators and facilities designed to support companies in the life sciences industry
- **People**
Enhance workforce education. State government's role should be to provide incentives to companies to pay for continuing education of workers in life sciences fields, offer financial support to students entering and completing life sciences degree programs, and encourage a stronger emphasis on life sciences education at the elementary and secondary school levels.
- **Money**
Develop creative and appropriate financing avenues for start-up and small companies. Tax policy incentives that offset current revenue is of small value to these companies and provides little in the way of incentive for technology business development. Possible actions include targeted tax credits, expanded support for incubators and innovation centers, pre-seed and seed capital funding initiatives, and dedication of a portion of the tobacco settlement funds to life sciences research and development.
- **Speed**
Promote technology transfer. Create incentives to encourage university researchers to engage in converting their life sciences research into commercial life sciences technologies and products in a timely fashion.

Goals

The state government's primary goal should be to prepare and implement a statewide strategic plan and develop programs that apply a statewide scope to support life science industries in Missouri. In order to become a leader in life sciences, there must be coordination of resources, programs, and industries in Missouri that constitute its critical mass in this important technology group. Otherwise, the obvious potential represented by this critical mass becomes a "critical mess." Missouri's plan and related programs should initially focus on four major objectives to become a leader in life sciences.

- Develop start-up, early stage, small and spin-off companies
- Research and commercialize technologies developed by universities, research hospitals, and/or Missouri businesses
- Develop the physical and programmatic infrastructure to enhance life science industries
- Educate and develop the necessary skilled workforce

Information Technology

What is Information Technology?

Information technology (IT) is a term used to describe a series of processes, products and services related to computers, software, telecommunications and the Internet. This is a convergence of computing and communications into one industry. IT forms the core of the new economy; and is revolutionizing the way we communicate, work, shop and play.

The importance of IT lies in its capacity to store, analyze and communicate information instantly, anywhere, at a negligible cost. IT is important in that: (1) it is pervasive, increasing efficiency and productivity in everything a firm does across all economic sectors; (2) it increases access to information, thereby allowing markets to work more efficiently by making transactions more transparent; (3) it is truly global, allowing firms to communicate and send information at almost no cost from anywhere in the world, thereby globalizing production and capital markets; and (4) it speeds up innovation by reducing the amount of time to process data and design new products.

The Information Technology (IT) sector includes telephone communications; telegraph and other messaging communications; cable and other pay television stations; other communication services; computer programming services; prepackaged software; computer integrated systems design; computer and data processing; information retrieval services; computer facilities management; computer rental and leasing; computer maintenance and repair; and other computer services.

Why Should Information Technology be a Target Industry for Missouri?

Information Technology (IT) is critical to Missouri as both an industrial cluster and an enabling technology. Because of its pervasiveness, the IT industry works as a magnet for companies in other sectors that desire to utilize its tools and talent. Given that the IT sector creates high wage jobs and has a significant positive impact on other economic sectors, the state should attempt to retain and recruit IT firms to Missouri. IT firms employ above average numbers of scientific and technical personnel, and possess above average research and development budgets. IT is already a major contributor to Missouri's economy.

- In 1999, there were 63,820 IT sector jobs in Missouri; this direct employment created an additional 121,188 ancillary jobs in the Missouri economy - for a total impact of 185,008 jobs statewide.
- In 1999, the IT sector directly accounted for 4.54% of total GSP in Missouri (\$6.93 billion); indirect and induced economic effects attributable to the IT sector accounted for 3.68% of GSP (\$5.63 billion). Taken together, the IT sector directly and indirectly accounted for 8.23% of total GSP in Missouri (\$12.57 billion).
- The creation of 100 jobs in the IT sector would produce \$5,066,327 in wages statewide, resulting in an average wage per job of \$50,663. This direct impact would also create an additional 190 ancillary jobs and \$4,896,179 in wages, for a total impact of 290 jobs and \$9,962,506 in wages across Missouri.
- In total, there are an estimated 100,000 to 130,000 IT workers in Missouri. The five fastest growing occupations in Missouri are all in the IT sector, and the projected annual rate of growth through 2006 is 11.6 percent.

If high-speed and advanced telecommunications can be thought of as the information super highway, the Internet is the vehicle for conducting commerce. It is projected that business-to-consumer transactions via the Internet will account for 8.6 percent of worldwide sales in 2004, and \$3.2 trillion of those sales will originate in the United States. Businesses are also increasingly using the Internet to complete transactions with business partners (business-to-business). This market is expected to grow from \$40 billion in 2000 to \$7.29 trillion in 2004.

While over 40 percent of United States small companies who have web sites are using the Internet to purchase goods and services, it appears that a much smaller percentage are doing so in Missouri. They are slow to adopt eBusiness technologies and processes due to a lack of awareness of eBusiness costs and benefits. Many businesses need the state's assistance to assess their operations and develop plans to begin using the Internet for business-to-consumer transactions.

Information Technology in Missouri Today

The DED Research & Planning office recently published a report on the IT industry in Missouri entitled *Information Technology in Missouri*. IT is clearly an industry sector that has the potential to benefit all communities throughout Missouri.

- IT employment and wages in Missouri are concentrated in the metropolitan areas of Missouri. However, it is not entirely an urban industry.
- IT software employment is concentrated in St. Louis County, Jefferson City, Wayne County, and Lincoln County and to a lesser degree in Springfield.
- IT services employment is concentrated in St. Louis County, northern Kansas City, Barry County, Maries County, and Polk County and to a lesser degree in Kansas City and Bowling Green.
- IT telecommunications services employment is concentrated in St. Louis City, Kansas City, Cape Girardeau, Princeton, Cameron, and Knox County and to a lesser degree in St. Charles and Hannibal.

Public Networks

Before discussing the telecommunications connectivity available to Missouri's businesses, it is important to recognize that Missouri is fortunate to have one of the nation's best public networks. MOREnet has successfully connected virtually all of the K-12 and secondary school districts, higher education, public libraries, and state government offices to a high-speed telecommunications network. MOREnet is currently providing Internet access to 511 of 524 school districts, 56 of Missouri's public and private four-year and two-year colleges and universities, and 125 of 147 public libraries. In addition to these locations, MOREnet also serves nearly twenty Community Information Network (CIN) sites which are telecommunications facilities maintained by local communities in order to meet local needs for unique value-added IT services. An additional nine sites are served through the University of Missouri Outreach and Extension's TCRC centers for rural communities created with the cooperation of the Missouri National Guard within armories.

There are 44 Incumbent Local Exchange Companies (ILECs), 75 Competitive Local Exchange Companies (CLECs) and 592 long distance carriers doing business in Missouri. In addition, there are five cable operators. High-speed broadband services are available in the larger urban areas of Missouri. In fact, St. Louis and Kansas City are among the top 50 cities in the United States in terms of telecommunications access according to a recent ranking reported in ZDnet Magazine. St. Louis and Kansas City were ranked 42nd and 36th respectively as of the end of 1999. In 1998, they were not ranked in the top 50. In contrast to the urban areas, many of Missouri's rural areas do not have access to advanced services. In fact, two-thirds of Missouri's zip codes do not yet have these services (537 of 801).

Urban vs. Rural Missouri

Connectivity to high-speed and advanced telecommunications is a prerequisite to meeting the competition for markets in the modern networked economy. Unfortunately, the necessary high-speed and advanced telecommunications services are unavailable in two-thirds of Missouri, mostly in rural areas. This serious threat must be addressed by a comprehensive statewide telecommunications plan.

Missouri cannot afford to let its rural communities fall behind other states and the rest of the world in its ability to compete in the digital economy of the twenty-first century. What is regarded as high-speed and advanced telecommunications service today will soon be viewed as basic service by nearly all businesses, no matter where they are located. One goal must be to provide advanced and high-speed telecommunications access to all areas of Missouri.

Our rural manufacturing companies, economic development lifelines for the future, need to address a rapidly expanding body of knowledge in the fields of integrated information management, ~~and~~ eBusiness. Technology-based service companies have an opportunity to take advantage of the amenities they can have by locating in rural communities while still being able to conduct lucrative business using the Internet. The late 1990's saw a rapid explosion of the Internet, accelerating pace of innovation, and heavy demands for technology professionals. Not surprisingly, the support community for technology services has located where potential revenue opportunities are the greatest, in urban centers. Manufacturing companies located in the rural regions of Missouri now find access to technology assistance and education to be difficult to locate, costly, and often times not focused on the challenges of manufacturing industries. This is accentuated by the shortage of employees with expertise in information technology. The out-migration of people and business from rural communities of the region, spurred on by an expanding technology and resulting business efficiency gaps, will continue if a strategy and program to support and nurture the implementation of emerging technologies is not created.

Large vs. Small Companies

While almost all large businesses have significant eBusiness operations and plans for expansion, an estimated 80 percent of Missouri's small businesses are not conducting eBusiness to any significant degree, other than to possibly have a passive web site. The problems appear to be:

- lack of awareness of eBusiness benefits and cost/benefits;
- need for assistance in assessing their operations and developing a plan;
- uncertainty where to look for assistance, and lack of time to conduct a search;
- concern that they do not have the requisite IT skills to develop and support eBusiness solutions,
- concern about the ability to conduct secure and private business over the Internet.

IT Research and Development

The size and growth rate of the IT workforce will tax Missouri's education and training resources to meet the needs. Missouri's educational system is responding in several ways, including offering new IT-related degree programs and adopting new distance learning technologies. While these developments are encouraging, the IT labor market remains tight (about 850,000 IT jobs will go unfilled in the U.S. this year) and is expected to continue for the foreseeable future, barring a dramatic change in the economy.

There are several universities in Missouri that are noted for excellence in IT R&D, including UMKC and Washington University for telecommunications research and UMR for intelligent systems and distance education. In addition, it appears that new R&D programs are emerging that innovatively combine IT in the classroom with new learning models to bring about entrepreneurial solutions.

Information Technology in Missouri Tomorrow

Rarely has there been a faster growing phenomenon than the Internet. It is transforming the way citizens, government, and businesses conduct commerce. With the boom of the IT industry already under way in Missouri, coupled with the necessity of IT as an enabling technology that spreads across the other target industries of the new economy, Missouri must continue to support developments in information technology. By focusing our efforts and resources on the IT industry, Missouri wishes to:

- Encourage new information technology businesses to form
- Attract out-of-state information technology companies to relocate to Missouri
- Ensure that information technology companies already here receive the support they need to stay and grow
- Identify new opportunities for companies by utilizing the enabling power of information technology

As with the other two target industries, to accomplish these goals the state must invest its resources in the four factors: technology, people, money and speed. The quality and availability of these four factors throughout our state will directly correspond to whether Missouri will be an international leader in utilizing the enabling technologies of the information technology industry.

Missouri's Four Elements of Success

- **Technology**
State government can take action to accelerate the use and integration of information technologies by companies by establishing and supporting institutes and incubators that support and develop the IT industry. In addition, the state must continue to find ways to increase access to advanced and high-speed telecommunications services.
- **People**
Improve the education and training needs of the IT industry and workforce. This includes educational opportunities in elementary, secondary and higher education. In addition, provide focused training for smaller companies to understand and utilize the advantages and cost/benefits of information technology, the Internet and eBusiness.
- **Money**
Develop creative and appropriate financing avenues for start-up and small information technology based companies. Possible actions include targeted tax cuts, training programs and capital funding initiatives.
- **Speed**
Encourage IT research universities in the state to expand their research and development activities, as well as partner with industry to expedite the commercialization their technologies.

Goals

While the current status of IT in Missouri is encouraging, the following are important goals with regard to technological, educational and training infrastructure.

- Many Missouri communities, especially rural, do not have access to advanced and high-speed telecommunications services. Missouri cannot afford to let its rural communities fall behind other states and the rest of the world in its ability to compete in the digital economy of the twenty-first century. What is regarded as high-speed and advanced telecommunications service today will soon

be viewed as basic service by nearly all businesses, no matter where they are located. One goal must be to provide advanced and high-speed telecommunications access to all areas of Missouri.

- To use an old analogy, if high-speed and advanced telecommunications can be thought of as the information super highway, the Internet is the vehicle for conducting commerce. It is projected that business-to-consumer transactions via the Internet will account for 8.6 percent of worldwide sales in 2004, and \$3.2 trillion of those sales will originate in the United States. Businesses are also increasingly using the Internet to complete transactions with business partners (business-to-business). This market is expected to grow from \$40 billion in 2000 to \$7.29 trillion in 2004. While over 40 percent of United States small companies who have web sites are using the Internet to purchase goods and services, it appears that a much smaller percentage are doing so in Missouri. They are slow to adopt eBusiness technologies and processes due to a lack of awareness of eBusiness costs and benefits. Many businesses need the state's assistance to assess their operations and develop plans to begin using the Internet for business-to-consumer transactions.
- The size and growth rate of the IT workforce will tax Missouri's education and training resources to meet the needs. Missouri's educational system is responding in several ways, including offering new IT-related degree programs and adopting new distance learning technologies. While these developments are encouraging, the IT labor market remains tight (about 850,000 IT jobs will go unfilled in the U.S. this year) and is expected to continue for the foreseeable future, barring a dramatic change in the economy

Advanced Manufacturing of Transportation Equipment

What is Advanced Manufacturing?

Advanced manufacturing has been summarized as “Tomorrow’s ideas at work today!” Advanced manufacturing practices help build products better, faster, and with less expense. Outcomes include increased capacity, lower inventory costs, optimized production, and better use of the workforce. Advanced manufacturing includes tools that reduce costs as well as obtain optimum efficiency for seemingly smooth production lines. Advanced technologies include cellular manufacturing, facility planning and plant layout, implementation of new technology, inventory control and material handling methods, just in time, lean manufacturing, concurrent engineering practices and cross function design teams.

The challenge for many manufacturers today is deciding on which technology or combination of technology is the best fit for their operations. Key to industrial modernization is no longer simply promoting advanced manufacturing technology (AMT) rather the issue is how to increase the intensity of AMT use and how to leverage this use for a competitive advantage. Special emphasis is needed on developing capabilities for adopting, implementing and managing AMTS.

Why Should Advanced Manufacturing of Transportation Equipment be a Target Industry for Missouri?

The 1998 Governor’s Economic Development Conference identified advanced manufacturing as a targeted industry cluster in the automotive, other transportation equipment, industrial machinery and metal products areas. As the crossroads to America, Missouri is well placed as an advanced manufacturer of transportation equipment. Missouri is already home to businesses that assemble automobiles, trucks, motorcycles, boats, aircraft, and other transportation equipment. In addition to assemblers of transportation components, many suppliers and vendors of machined parts, fabricated sections, small engines, subassemblies, and parts are also located in Missouri.

Presently, a critical mass exists in this state to maintain and enhance our leadership in the transportation equipment industrial cluster. Companies like Ford Motor Company, Daimler-Chrysler, General Motors, Boeing, and Harley-Davidson already operate in Missouri. Advanced manufacturing concepts and techniques are the keys for Missouri to enhance its national stature in the transportation industry.

The advanced manufacturing of transportation equipment industry in Missouri accounts for:

- 4.4% of the Gross State Product, and generates an additional 6.6% indirectly
- 62,592 citizens employed by 310 employers throughout Missouri as of August 2000 (representing 13.34 % of the manufacturing workforce). This is up from 55,590 citizens and 249 employers in 1995.
- The creation of 100 jobs in the Advanced Manufacturing of Transportation sector would produce \$???? in wages statewide, resulting in an average wage per job of \$????

Advanced Manufacturing of Transportation Equipment in Missouri Today

Key programs in this state are already in place with experienced and well-trained staffs to offer assistance to advanced manufacturing companies to make them more efficient by increasing profits and cost savings. These programs include the Missouri Enterprise Manufacturing Extension Partnership program, the state's four innovation centers, and venture capital programs.

The workforce required to staff high performance transportation equipment manufacturing operations must be able to communicate effectively as a member of a working team, be trained in a full range of skill sets, and have an understanding of the nature of the industry and the role they play as an employee. The state's colleges and universities have been vital to this effort. However, their contribution can be enhanced by establishing cross-functional, integrated centers to support transportation equipment advanced manufacturing through education curriculum, workforce training, support of industry advisory boards, and applied research.

Ominous signs are on the horizon. Missouri companies that were formerly national and international leaders are being purchased, downsized, or moving their headquarters out of the state. Recent examples include McDonnell Douglas, Monsanto, Southwestern Bell, Purina, and TWA.

The good news is that these companies left a legacy of quality workers, technology development, and spin-off businesses that can anchor a technology comeback for Missouri and launch state Fortune 500 companies of the future. The critical mass is here. Missouri can, and will, become an international leader in key industrial clusters, if it makes the necessary investment.

Advanced Manufacturing of Transportation Equipment in Missouri Tomorrow

The state must provide encouragement to transportation equipment advanced manufacturing firms as a targeted industry for Missouri. State government should do this by utilizing and improving our programs to constantly update the quality and performance of their products, continually increase cost savings and improve their productivity and profitability, invest in their workforce and modern manufacturing practices and management.

In order to accomplish these goals, the state must invest its resources in the four factors of success: technology, people, money and speed. The quality and availability of these four factors throughout our state will directly correspond to whether Missouri will continue to be an international leader in advanced manufacturing practices for the transportation equipment industry.

By focusing our efforts and resources on advanced manufacturing companies in the state, Missouri wishes to:

- Encourage new advanced manufacturing practices and transportation equipment companies to form
- Attract out-of-state transportation equipment companies to relocate to Missouri
- Ensure transportation equipment companies already here receive the support they need to stay and grow
- Identify new opportunities for companies by utilizing advanced manufacturing tools to streamline operations to become more cost efficient and productive

Missouri's Four Elements of Success

- **Technology**
Facilitate the modernization of technology and business practices within the transportation equipment manufacturing sector (SIC 37) by enhancing the technical and managerial ability of engineers and managers. Enable them to identify and absorb new technology and innovation through investments into technology programs and incubators.
- **People**
Develop Missouri's transportation equipment advanced manufacturing firms into high performance work organizations by better alignment of education with workplace needs. This would include apprenticeship and employee certification programs, assessment of competence levels. The shortage of skilled workers and managers could be offset increased industry specific training opportunities.
- **Money**
Establish market-driven procedures to encourage innovation and highly evolved concepts in advanced manufacturing of transportation equipment to be pulled out of the university research and innovation centers in a more expedient manner.
- **Speed**
Accelerate the use of advanced technologies and manufacturing practices within small and medium manufacturers through the increased support for a statewide NIST manufacturing extension partnership (MEP) program.

Goals

- Facilitate the modernization of technology and business practices within the transportation equipment manufacturing sector (SIC 37) as well as supporting manufacturing and service sectors,
- Establish market-driven procedures to encourage innovation and highly evolved concepts in advanced manufacturing of transportation equipment to be pulled out of the university research and innovation centers.
- Accelerate the use of advanced technologies and manufacturing practices within small and medium manufacturers through the increased leveraging of federal funds for the NIST manufacturing extension partnership (MEP) program.
- Enhance the technical and managerial ability of engineers and managers within the transportation equipment manufacturing and support industries to be able to identify and absorb new technology and innovation.
- Develop Missouri's transportation equipment advanced manufacturing firms into high performance work organizations by enhancing the job skills through better alignment of education with workplace needs that include apprenticeship and employee certification programs and assessment of the attainment of specific levels of competence.
- Overcome the severe shortage of skilled workers and managers by assisting employers update their employee and managerial skill sets through increased funding for the customized training program as well as expanding the customized training program management to the University of Missouri system and state colleges and universities.
- Accelerate the development of connectivity in rural areas by Internet Service Providers (ISP) to allow small and medium firms better access to the Internet to conduct Business-to-Business and Business-to-Consumer interchange

Technology

This section looks at three areas that support and fund the development of technology which must be addressed for Missouri to be a technology leader in the new economy: general revenue funding for technology, federal research and development funding, and state technology organizations. State government can make a profound impact on the potential for success of Missouri companies by addressing these three areas. This section also compares Missouri to other states around the country on these support issues.

The State of the State in Technology Investment

Research and development is the cornerstone to all three targeted industrial clusters and moving Missouri into the first tier of technology-driven states. While statistics show Missouri to be well placed in innovation, technology, and research, deeper inspection reveals that this could be a house of cards, if a statewide technology strategy is not immediately developed and implemented. Missouri must also create partnerships if the Missouri companies and organizations are to be viable for U.S. Small Business Innovation Research (SBIR), National Science Foundation, and ATP grants. For instance, the National Science Foundation ranks Missouri 11th in the nation in total research and development funding provided by the federal government. If you take away the federal dollars flowing through three institutions (Washington University, Fort Leonard Wood, and Whiteman Air Force Base) this ranking falls dramatically.

Science and technology issues are well positioned on the radar screen of many governors, based on a State Science and Technology Institute (SSTI) review of more than 50 gubernatorial addresses. In SSTI's latest issue brief, *Science, Technology and the Governors: Excerpts from the 2000 Gubernatorial Addresses*, SSTI compiles 117 excerpts across a range of S&T concerns: new initiatives, biotechnology, university research capacity, the New Economy, e-commerce, technology-related tax credits, seed and venture capital, information technology and workforce development.

A review of the governors' addresses emphasizes, again, that state support for science and technology transcends political parties, demographics, and economic conditions. Quotes in the issue brief come from 38 governors. The 2000 review indicates a large increase in the number of governors talking about biotechnology (13 in 2000 versus 5 in 1999), a reflection of some states' use of tobacco settlement funds for biotechnology research. There was a significant decline in the number of governors discussing access to higher education (7 in 2000 versus 20 in 1999); this may be due to action in 1999 establishing scholarship and forgivable loan programs.

The globalization of markets, as well as the pervasiveness of technology are significantly changing Missouri's and the nation's economic landscape. Moreover, the same forces that are transforming the economy are transforming government. Companies need to also understand the economic and operational implications of eBusiness and make use of an expanding body of scientific knowledge and technology innovation.

In the new economy, the fastest-growing regions are those attracting firms that constantly innovate, bring new products to market, and maximize the use of technology in the workplace. Such firms typically seek environments that encourage research and development (R&D), and possess state-of-the-art R&D facilities with the necessary intellectual talent. These firms foster the rapid introduction of new products into the marketplace through technology transfer.

To this end the state university system, traditionally the major site for public research and development, is the most powerful tool state governments have to create such an environment. According to a recent report prepared by the State Science and Technology Institute (SSTI) in conjunction with the National Science Foundation (NSF), twenty-nine of the top thirty fastest-growing, high technology metropolitan areas are home to, or very near, a research university. States can also spur R&D in the private sector through activities that encourage industry-led R&D and university-industry partnerships.

Missouri has not benefited from the research that has been conducted at research institutions in comparison to many other areas of the nation. Missouri has several well-known research institutions but past conditions have not been favorable for the transfer of technology and commercialization by the private sector in the state. Recently there has been recognition that more needs to be done to encourage university-industry partnerships and university intellectual property policies that benefit all parties.

Missouri General Revenue Funding for Technology

Two programs administered by the State of Missouri that directly impact R&D are the Centers for Advanced Technology (CATS) and Innovation Centers. These are Missouri's primary programs for enhancing research and development, as well as technology transfer. Both of these provide financial assistance and expertise for research aimed at improving or creating new products, affordable space, and technical resources to Missouri companies. (moved from below) Ironically, general revenue funding for these two programs has dwindled from just over \$3 million in 1990 to \$1.9 million in FY 2001. As of 1990 the total GR funding appropriated for the CATS totaled \$1,750,000, while GR funding for the Innovation Centers was \$1,337,500. The total for CATS and Innovation Centers in 1990 was \$3,087,500. Over the past ten years the appropriation has decreased for these two programs to a total of \$1,915,172 in FY2001. Consequently, GR funding in real dollars was greater in the late 1980's and early 1990's than it is now.

TOTAL GENERAL REVENUE FY90, 95, 2000 COMPARED TO 1990 DOLLARS			
FISCAL YEAR	FY90	FY95	FY2000
CATS FY APPROPRIATION	1,750,000	940,532	940,532
1990 Adjusted Inflation Value	1,750,000	810,443	706,050
INNOVATION CENTERS FY APPROPRIATION	1,337,500	974,640	974,640
1990 Adjusted Inflation Value	1,337,500	828,828	731,650
TOTAL FISCAL YEAR GENERAL REVENUE FUNDING	3,087,500	1,915,172	1,915,172
1990 Adjusted Inflation Value	3,087,500	1,639,271	1,437,700

NOTE: 1990 HIGHEST YEAR OF GENERAL REVENUE APPROPRIATION

Missouri vs. Other States

Missouri's current level of general revenue funding is a drop in the bucket compared to states with serious technology programs like Pennsylvania (\$43.4 million), Ohio (\$40.4 million), Georgia (\$39.3 million), North Carolina (\$36.9 million), and Texas (\$29.4 million.) Even Kansas spends \$11.5 million. Missouri cannot become a first-tier technology state with the current level of state-government investment.

Missouri is not in the same financial support league with those states considered to be our competitors in the world marketplace. General revenue funding in those jurisdictions by our competitors has generally far exceeded Missouri's efforts in funding technology and R&D activities.

States' Current Investments in the New Economy		
	State	FY99 General Revenue Funding
	Pennsylvania	\$43.4 million
	Ohio	\$40.4 million
	Georgia	\$39.3 million
	North Carolina	\$36.9 million
	Texas	\$29.4 million
	Indiana	\$25 million
	Michigan	\$15 million
	Kansas	\$14.5 million
	Maryland	\$12.1 million
	Virginia	\$11.5 million
	Missouri	\$1.9 million

Source: State Science and Technology Institute

■ State Funding for Cooperative Technology Programs
GENERAL REVENUE DOLLARS REPORTED IN MILLIONS --- States' Annual Budget Documents

The State of Kentucky recently invested \$53 million in the implementation of the Kentucky Science and Technology Council's first science and technology strategic plan. The strategic plan received the support of the governor and the state legislature.

The State of Ohio recently completed an economic impact study of the Edison Technology Centers and the State's economic development efforts. The new economy's impact on Ohio's economic development efforts were looked at from several perspectives, including company competitiveness, job savings and retention, personal income, company sales, state tax collections, and funds leveraging. The Edison Technology Centers were established to support public-private partnerships that diversify Ohio's economy through technological innovation.

The Michigan Economic Development Corporation developed a statewide information technology strategy and a life sciences strategy. This plan is being used as the guidelines for development of Michigan's new \$1 billion Life Sciences Research Corridor Program that was funded from the tobacco settlement. Michigan also uses substantial revenue receipts from gaming to fund its science and technology development efforts.

The State of Georgia: the Georgia Center for Advanced Telecommunication (GCATT) is a major thrust into the new economy. GCATT is a telecommunications technology development partnership of government, universities, and the advanced telecommunications industry. To accomplish its vision to become the premier center in the world for advanced telecommunications for the 21st century, Georgia used gaming receipts to fund its capital outlays related to the development of science and technology centers, particularly, for the development of the Georgia's Center for Advanced Telecommunication's.

This investment of gaming receipts keeps Georgia at the forefront of the development of fiber optics and ISDN technologies. Consequently, Georgia is now the transmission hub for the country's two largest fiber-optic trunk routes. One finds more miles of fiber-optic trunk lines deployed in Georgia than in any other state because of this continued commitment to public-private partnership investment in tomorrow's infrastructure. GCATT is well known as a source of information and outreach to the technology community. The center acts as a hub connecting a variety of research centers, government agencies, private companies, and industry groups. The GCATT building is a showcase of Georgia's leadership in the information industry, and it houses a variety of research programs with a national and global presence. This type of development comes from continuous commitment to fund innovation and technology at all stages of the development chain in order to avoid falling behind.

Federal Research and Development in Missouri

In recent years, the federal government has spent approximately \$1.4 billion annually in Missouri on research and development (R&D) activities, which ranks Missouri 11th in the nation in total R&D funding. On average, federal R&D dollars account for approximately 10 percent of all federal funds spent in Missouri each year on matters other than the direct support of individuals (i.e., such entitlements as retirement, disability, and housing assistance). There seems to be a quick and steady flow of R&D dollars to Missouri, indicating that the federal government sees Missouri as a center for R&D activities. However, Missouri has not been successful in fostering and developing partnerships between research universities, private research institutions and businesses already conducting R&D. Missouri plants the seed of R&D with federal funding, but fails to nurture the plant until it grows and thrives.

While Missouri ranks 11th nationally in total R&D funding, according to the National Science Foundation (NSF), this ranking is largely attributable to funding of activities conducted by the federal government at Washington University, Fort Leonard Wood and Whiteman Air Force Base. The University of Missouri has also begun to show marked improvement in attracting R&D dollars over the past year. However, until this past year, their R&D activities have been widely scattered over a large number of disciplines.

Most major federal agencies that currently support federal R&D efforts provide funding for R&D activities in Missouri. Foremost among these agencies is the Department of Defense (DOD), which provides 76 percent of the federal R&D dollars spent each year in Missouri. The Department of Health and Human Services (HHS) accounts for another 16 percent. The remainder of the federal R&D dollars spent in Missouri each year comes from the Department of Agriculture (USDA), the NSF, and several other agencies.

All federal R&D dollars spent in Missouri either cover the costs of operating federal R&D units in the state, including paying the salaries of federal R&D personnel working at these units, or are awarded as grants, contracts, or cooperative agreements to entities in the state.

Data reported in the State Science and Technology Digest, April 1998, from the NSF, entitled "Six States Account for Half of the Nation's R&D," analyzed the distribution of research and development activity by state and found most of the activity is concentrated in a small number of states. As the data brief reports, six states—California, Michigan, New York, Massachusetts, New Jersey, and Texas (in decreasing order of magnitude) — account for half of the nation's R&D. California's level of R&D expenditures was \$36 billion and represented approximately one-fifth of the \$177 billion U.S. total.

The top ten states (adding, in descending order, Illinois, Pennsylvania, Maryland and Ohio) accounted for nearly two-thirds of the national effort. The 20 highest-ranking states in R&D expenditures accounted for approximately 85 percent of the U.S. total. The lowest 20 states accounted for five percent.

NSF also examined the states' R&D activity in relation to the size of their economies as measured by the Gross State Product. The proportion of their economies devoted to R&D activities is presented in terms of "R&D intensity." California and Michigan—the two highest ranking states in total R&D—also ranked high in terms of R&D intensity. However, New York (which ranked third in overall R&D performance) had a relatively low 1.8 percent rating for R&D intensity.

NSF suggests that the R&D performance of New York, Texas, Illinois, Pennsylvania, Ohio and Florida is closely related to the state's overall economic size rather than portion of their economies devoted to R&D. In contrast, Massachusetts, New Jersey and Maryland have high R&D levels in relation to their economic size.

Top 10 States Receiving Federal R&D

Rank	Total R&D Performance	R&D Intensity (R&D/GSP)
1	California	New Mexico
2	Michigan	District of Columbia
3	New York	Michigan
4	Massachusetts	Massachusetts
5	New Jersey	Maryland
6	Texas	Delaware
7	Illinois	California
8	Pennsylvania	Connecticut
9	Maryland	Rhode Island
10	Ohio	Idaho
11	Missouri	Missouri

Overview of State Technology Organizations

State science and technology-based economic development programs are generally structured in one of three ways: as part of the economic development or commerce department, or the governor's office; a stand alone agency or commission in state government or a quasi-public corporation; or an independent, 501(c)(3) nonprofit organization.

Exactly half of the states (25) have their science and technology programs housed in the state's economic development or commerce department or the governor's office (or in Colorado's case, in the Commission on Higher Education). The other half are either fairly autonomous or completely independent corporations. It should be noted that even the independent, 501(c)(3)s rely heavily on state funding and would likely cease to exist if the state funding ended.

For the most part, programs that are housed in state's economic development or commerce departments are relatively small (e.g., Alabama, Idaho). There are significant exceptions to this with Ohio and Pennsylvania being the prime examples. The bulk of the activity in those states occurs at independent organizations funded by the states (the Edison Centers and Ben Franklin Technology Centers).

It is difficult to characterize the trend in organizational development. For example, within the last two years, two states have set up organizations outside state government (Maryland and Michigan), while three states have brought programs back in closer to state government (Colorado, Rhode Island, and New York). Two other states have retained the quasi-public status of their organizations, while exerting more control over them from the executive branch (Oklahoma and Virginia).

Prior to that, the trend had been toward greater autonomy for the state programs. For example, Kansas, Kentucky, and Maine's lead organizations were all part of state government at one time, but were spun out to provide them with more flexibility in operations.

States have generally found that by having the lead science and technology programs outside state government, the programs can: 1) have higher credibility with the business community; 2) attract and retain high quality staff; and, 3) be more responsive to business needs. One disadvantage is that the programs have the potential to become removed from the political arena and may not be in touch with gubernatorial or legislative priorities, which in the end threatens their very existence.

Goals

- Increase the amount of general revenue spent on technology development.
- Increase the amount of federal research and development funding for Missouri projects.
- Increase the efficiency of state technology organizations and programs.

Recommendations for Promoting the Technology Element

Office of Science and Technology and the Missouri Technology Corporation

Missouri needs to invest in both people and activities that are related to technology development in the state. While the Missouri Technology Corporation serves in an advisory capacity to the Governor and the Department of Economic Development (DED), it receives no funds from the General Assembly. This needs to change in the future if the state is to have a viable group of business and technology leaders to champion science and technology development.

No office in the state has been designated to promote science and technology. Presently the technology programs are a part of the Office of Productivity within the Business Development Group along with the National Institute of Standards and Technology (NIST) /Manufacturing Extension Partnership Program. The Office has one full time employee that oversees all of the programs and coordinates technology development activities. This certainly does not present the impression that the state looks at technology issues as being a high priority.

A Missouri Office of Science and Technology (MOST) should be established in DED with a director and staff knowledgeable of the industry clusters that have been identified as having the best potential for growth in Missouri. In addition to the Office being established, there needs to be a significant appropriation made to the Missouri Technology Corporation to be matched by the private technology sector in the state for science and technology activities. The investment in this area of development should be no less than any other development activity the state funds and promotes, and certainly should make Missouri competitive against other states.

The following would be functions of this office.

- Partner with the MTC to operate cohesive science and technology program.
- Promote and market Missouri advantages to technology-based companies, emphasizing life sciences, information technology, and advanced manufacturing transportation,-with staff members assigned to each industry cluster.
- Administer state programs designed to assist these targeted industries.
- Develop programs to increase amount of federal and private research funding flowing into Missouri.
- Develop a knowledge-based economic development strategy.
- Complete an audit of state government practices and their impact on Missouri entrepreneurs.
- Increase university involvement in state economic development and technology transfer efforts.

- Promote university/industry interaction.
- Research best practices of other states in technology development and transfer.
- Coordinate development of advisory groups and roundtables capable of developing strategies to promote specific targeted industrial clusters.

Cost -- \$500,000 annually for operations.

CAT PROGRAM

The days of each manufacturing firm conducting its own research and development (R&D), except in rare cases, is gone. R&D efforts are still required if a manufacturer is to survive and prosper, but these efforts are now accomplished with outside resources, primarily within colleges and universities. In order to stimulate these partnerships among the participants, state tax credits and partial state support through special appropriations for the manufacturing technology must be used as an incentive to promote collaboration across the three target industries.

Missouri can stimulate more industry/university research collaboration by targeting tax credits and leveraging increased industrial support with state matching funds through an expanded and reorganized Center for Advanced Technology (CAT) program. Tax incentives can be implemented to encourage industries to replace older equipment with more efficient, modern machinery.

State funds should be allowed to leverage federal research dollars along with industry match, specifically for projects that will result in fairly quick application of developed technologies. These incentives should be made available to all university system and state colleges and universities to allow different collaborative teams and concepts to compete for these scarce resources. By requiring industry funding partners, technology transfer is dramatically increased.

Cost – Another \$3.3 million should be added to the present funding level of \$950,000.

NSF INFORMATION TECHNOLOGY RESEARCH PROGRAM

(IT) To build on this objective, we need to encourage Missouri's research universities to pursue new federal research funding opportunities made available through NSF's Information Technology Research Program. This includes determining proposal status and whether Missouri can assist individual institutions and researchers to identify opportunities and enhance chances for success.

Cost - To be determined

MO E-BUSINESS INSTITUTE

Make it easier for Missouri's small businesses to learn about IT-related assistance programs and where to go for help by developing a comprehensive on-line directory of IT-related assistance services and make it accessible through a state-sponsored Internet website.

The recommendation to achieve this goal is to establish the Missouri eBusiness Institute (MO-eBI) as a coalition between the NIST-Manufacturing Extension Partnership Center in Missouri and the University of Missouri System eBusiness program. MO-eBI will serve as the focal center for project coordination and partnership building between manufacturers, education, communication and leading computer hardware, software, and service companies. Services provided by MO-eBI will include:

- Providing overall project coordination.
- Providing technical resource services to the state initiatives – staff skills available will include; Telecommunications Specialist, Network/Systems Administrator, Database/Software Engineer, Internet Media Integrator.
- Maintaining an Application Service Provider (ASP) infrastructure – T1 connected server resources to incubate websites, email domain services, and secure eBusiness transaction processing.

- Offering an Application Hosting Service to educational institutions in Missouri by providing access to state-of-the-art computing facilities with the latest in eBusiness software and hardware, educational material, and know-how.
- Developing curriculum and training materials that could be used in academic institutions as well as by businesses.
- Building tools to assist the manufacturing and information technology specialists in the state (i.e. – assessment tools, implementation guides, and others as identified by field staff).
- Delivering individual consulting services to the companies of the region as requested by the state initiatives.
- Developing business relationships with international leading computer software, hardware and tooling companies.
- Creating a partnership with higher education institutions in Missouri that can assist in: (a) matching students with companies for the purpose of facilitating student technology projects (samples – student builds a dynamic website for a company, student facilitates training at a company, student develops an application for a company, student assists in the installation of a company LAN and connection to the Internet); (b) linking faculty interested in applied eBusiness and information technology research initiatives to companies seeking original solutions; (c) delivering Certification Workshops/Seminars; and (d) facilitating internship placement of students with companies looking for IT and computer talent.
- Building and maintaining the MO-eBI portal on the Internet as an information resource for Missouri initiatives and the businesses of the region.
- Maintaining a high-profile, nationally recognized, advanced demonstration and R&D facility that integrates the latest eBusiness technologies from the leading software and hardware vendors and provides faculty and corporate researchers access to the necessary IT infrastructure and sandboxes to successfully conduct their research.

It is recommended that Missouri proceed to establish and fund the MO-eBI as soon as possible. The outcomes of the MO-eBI will be measured in the same manner as the Missouri NIST/MEP center uses in order to gauge customer satisfaction and economic impact. Namely, all companies receiving assistance from the MO-eBI will be required to sign a formal contract which will set forth the scope of work to be done, the timeframe, who will do the work, and the cost. In addition, the company will be required to agree to participate in a post-project survey. In addition, all participants in eBusiness seminars and conferences will be asked to complete an evaluation survey. In this way, Missouri will be able to measure the results of MO-eBI on a continuous basis. It is expected that MO-eBI will begin producing results within several months of start-up as projects and seminars are completed.

Cost: It is expected that the cost of the program will be \$2 million per year after it becomes fully operational. State funding commitments will decline after the first year as the program secures other sources of funding and becomes a sustainable operation. There is a strong possibility for obtaining NIST/MEP funding for MO-eBI as a national pilot program if state support is forthcoming. MO-eBI will also pursue other sources of funding, including client fees, membership fees, application hosting service fees, and annual conference fees. These will gradually increase as MO-eBI becomes well known to Missouri businesses and national funding agencies. Missouri funding is recommended as follows:

FY2001 – FY2004:	FY2001	\$1,000,000	FY2002	\$ 750,000
	FY2003	\$ 500,000	FY2004	\$ 500,000

These funds should be matched on at least a 1:1 basis from other sources.

INCUBATORS

Provide tax credits for creating additional technology business incubators or expanding capacity of existing operations in life science cluster or potential cluster geographic areas.

Cost -- \$1.5 million one time.

INNOVATION CENTERS

Continue support of existing innovation centers and expand the program into other geographic clusters, such as Springfield and Cape Girardeau, to increase support to the three targeted industries in Missouri. This would require funding the operations of four existing centers and at least one additional center. Over the past five years, funding for the four Innovation Centers has either remained stagnant or has been reduced due to budget concerns. The original funding allocated in 1986 was \$1.6 million. The funding decreased steadily and bottomed out at \$974,640 for the past seven years, until being reduced in FY2003 to \$864,118. Currently, the four Innovation Centers each receive approximately \$200,000. According to the 2001 study, "Does Technology Incubation Work? A Critical Review," by David Lewis of Rutgers University for the U.S. Economic Development Administration, states that the average annual operating cost of a targeted incubator is \$448,629.00.

The four current Innovation Centers, located in St. Louis, Kansas City, Rolla and Columbia will receive an increase in funding of up to \$200,000 each.

Cost -- \$2.0 million annually @ \$440,000 per year per center.

TAX CREDITS/BONDS TO DEVELOPERS OF TECH SPACE/LABS

Provide tax credits to developers developing speculative rental space for technology-based companies. Also, provide tax credits for companies fitting out their own space and purchasing equipment. Since tax credits are limited, as an addition to or an alternative to tax credits, the Missouri Development Finance Board could issue bonds and create a low-interest revolving loan fund for the construction and fit-out of facilities with labs.

Cost: \$10 million annually in 25% tax credits \$50 million in bonds to create a revolving loan fund.

GRANT and PROPOSAL WRITER/CONSULTANT

Fund grant and proposal writer positions within each of the state-affiliated innovation centers to help technology-based companies prepare winning SBIR/STTR and other research funding proposals.

Cost: \$300,000.

MEP CONSOLIDATION

All NIST Manufacturing Extension Programs (MAMTC) should be consolidated under the only provider of these services headquartered in the state, Missouri Enterprise. Missouri Enterprise – MAMTC, the Innovation Centers and venture capital efforts for the 2000s must continue to focus on assisting existing firms to deal with global competition with modern manufacturing practices (lean manufacturing, inventory control, statistical process control, application of computers to product design and production control, ISO / QS 9000, ISO 14000, and e-commerce, marketing, and application of technology to both the production process and products, and management).

Missouri Enterprise – MAMTC, the Innovation Centers, Small Business Development Centers, and venture capital efforts must also provide marketing, assessments and financial planning and business planning assistance to start-ups for the three targeted industries. State investment in these programs has historically paid big dividends to Missouri's economic progress. (i.e. one dollar spent by Missouri for Missouri Enterprise-MAMTC program results in a state economic impact of \$86.)

Cost -- Consolidation of all NIST Manufacturing Extension Programs under one program administrator should reduce overhead costs and retain enough earnings in Missouri to prevent adding additional funding to implement this action.

LEGISLATOR TRAINING

Missouri's Office of Technology and relevant trade associations can cooperate design and implement a program designed to educate state and federal legislators regarding current and future technology issues in the fields of information technology, life sciences, and advanced manufacturing.

ADVISORY GROUPS AND ROUNDTABLES

To ensure that IT economic development policy and legislation is founded on the sound counsel of industry, academic and other appropriate constituencies, it is recommended that Missouri establish a high level IT Advisory Committee consisting of top business, academic, and economic development leaders. Quick action should be taken to form the IT Advisory Committee so that work can be commenced on planning for the IT Roundtable and IT Strategic Plan. Measurement of the outcomes will be fairly simple.

Cost: Approximately \$50,000 per year.

The IT/Telecommunications roundtable should be prepared to address the following items.

1. Complete a telecommunications inventory of private and publicly-owned telecommunications and cable facilities.
2. Complete a survey of companies offering local services to gather more information about the availability, characteristics, and plans for advanced and high-speed services. The survey will also gather information about the barriers to investment in and use of advanced and high-speed services.
3. Identify existing regulations and other legal barriers that discourage competition.

This roundtable should be comprised of the Public Service Commission, the Public Counsel, IT industry leaders, telecommunications providers (both large and small), economic development officials, academia, state and local elected representatives, and consumers. The availability of advanced and high-speed telecommunications prepares Missouri to compete globally from anywhere in the state.

INDUSTRY SURVEYS

Missouri's R&D institutions should be surveyed by the appropriate representatives from DED to determine plans for IT and life sciences R&D projects, funding sources, and whether there is any role that the state could play in assisting achievement of success.

Cost: To be determined based on the outcome of the survey.

TECHNOLOGY CONFERENCES

Conducting an Annual Conference that brings the state centers and initiatives, educational institutions, and the businesses of the region together to learn from each other and to examine emerging technological innovations.

Cost: \$150,000 per year.

PUBLIC RECOGNITION

Missouri should acknowledge and publicize the achievements of Missouri's research and technology-driven enterprises.

Cost: To be determined.

People

This section emphasizes the importance of skilled labor for the three technology targeted industries in the new economy. Solid math and science skills for elementary and secondary students are the foundation of a skilled workforce in the new economy. In addition, working adults must have access to continuing education to increase their higher education skills in order to stay competitive in technology driven industries.

Mathematics – the Language of Technology

It is a new economy. A technology-driven economy demands a workforce whose quality is measured in terms of skill sets, proficiency, and level of education. In an increasingly technological world, mathematical knowledge and skills are key to both national and personal success. If Missourians are going to boost their standard of living and capitalize on the opportunities of the new economy, its citizens must be proficient in mathematics. We must strive to ensure that graduates from Missouri high schools and colleges are the most competent in mathematics in the United States and the world.

Over the past several years, Missouri employers have been seeking workers with higher-level mathematics skills. Unfortunately, many sources indicate that Missouri residents and students rate average, at best, in mathematics skills. Recent surveys of employers indicate that the lack of skilled workers is hampering the expansion of many companies. Community colleges are required to provide remedial mathematics training to a significant percentage of high school graduates to bring them to an adequate level of proficiency necessary to work for many companies or effectively master college level mathematics courses.

Elementary School Report Card

Missouri's school children measure competitively against children throughout the nation and world when tested for mathematics skills during the 4th grade. However, by the time they are tested in the 8th grade, Missouri and U.S. students are no longer competitive.

The Department of Elementary and Secondary Education (DESE) set a high standard for mathematics understanding to be used in the Missouri Assessment Program (MAP), which measures student progress in 4th, 8th, and 10th grades. In fourth grade, 36.72 percent of Missouri students tested at proficient and advanced levels in the year 2000. By the 8th grade, though, only 14.06 percent test at these higher levels, and in 10th grade the number drops to 10.34 percent.

Missouri students do well at computing rows of numbers, but lack the ability to actually apply mathematics to real world applications. The problem is noted in test scores between the 4th and 8th grades when students should be able to move from computation to concepts.

Secondary School Report Card

Missouri college students report the need for stronger high school preparation in mathematics. For example, findings from a Coordinating Board for Higher Education (CBHE) sponsored 1988 survey of currently enrolled college students in the state's public two- and four-year colleges and universities show that at both two- and four-year institutions, great majorities of surveyed students (78 percent) see mathematics as an indispensable component of college education. About one fourth of the survey respondents, however, reported that their high school mathematics courses had not prepared them well for college courses.

In 1999, the CBHE sponsored a statewide survey (Counseling for High Skills) involving 5,400 students enrolled in Missouri public and private two-year postsecondary technical education programs. Findings from that survey show that students' retrospective assessments of their high school coursework, mathematics (algebra and above) and computer competencies were frequently referred to as top factors for doing well in postsecondary technical education programs.

Missouri's college bound students have consistently scored at or above the national average on the mathematics and science reasoning sub-scales of the ACT college admissions assessment:

<i>High School Graduating Class of:</i>	<i><u>Missouri Mathematics</u> Sub-Scale Score</i>	<i><u>National Mathematics</u> Sub-Scale Score</i>	<i><u>Missouri Science</u> Reasoning Sub- Scale Score</i>	<i><u>National Science</u> Reasoning Sub- Scale Score</i>
1995-96	20.5	20.2	21.6	21.1
1996-97	20.9	20.6	21.6	21.1
1997-98	21.0	20.8	21.6	21.1
1998-99	20.9	20.7	21.5	21.0
1999-00	21.0	20.7	21.6	21.0

Technology Workforce - New Demands in Higher Education

The state of Missouri has a strong four campus research university, a major private research university, a network of well located state universities, a significant number of excellent private colleges, and a broad distribution of community colleges. The issue for the state with respect to technology driven economic development is how to enhance this resource and engage it in activities that promote economic development.

The universities in the state of Missouri provide the full range of programs and course work required to prepare a technologically competent work force. These programs and courses do not have large enrollments. There do not seem to be effective incentives to encourage the desired enrollments in technologically sophisticated programs and courses. Most students enroll in traditional programs and the universities tend to promote programs that students want rather than programs the students need in a technologically based economy and that the state needs to promote the development of a technologically based economy. The distribution of faculty in the universities is largely based on the demand from traditional curricula. To focus the universities on the development of a workforce appropriately educated to meet the needs of technologically oriented businesses will require the development of strong incentives for both the students and the universities. The state must recognize the higher cost of science, engineering, computer and mathematics programs in comparison to courses which can be taught in large lecture sections and reflect these costs in university funding.

The universities have a role in educating the general population about emerging technologies. Many students complete their formal education without gaining a basic understanding of the technologies that they must employ in their jobs and in their everyday life. The result is a population that is unresponsive to opportunities that result from the rapid changes driven by the new technological developments. The real economic impact of a technology only occurs when the average employee is willing to utilize it. A technologically educated population will assure that the state can gain the efficiencies provided by a new technology quickly.

A major objective would be to continue to develop and strengthen a comprehensive postsecondary technical education delivery system through the *State Plan for Postsecondary Technical Education* in highly advanced mathematics and science based programmatic areas, e.g., those that support the life sciences.

The Missouri Department of Elementary and Secondary Education and the Department of Higher Education are best situated to create education plans to support the development of a technology workforce needed to carry out this technology plan. Because DED is not the agency that should initiate such a plan, this document will only focus on changes DED can undertake that will supplement either education or workforce development programs.

Goals

- To ensure that graduates from Missouri high schools and colleges are the most competent in mathematics in the United States and the World. Evidence of strength in mathematics will be based on national standardized examinations.
- To increase the number of Missouri's students graduating with mathematics degrees. Evidence of increased rate of graduation of mathematics majors.
- To attract and retain Missouri mathematics graduates in Missouri businesses. Evidence of success will be based on surveys of employers and the number of workers employed in those classifications requiring skills in mathematics.
- To increase and maintain the number of qualified Missouri mathematics teachers. Evidence will be follow-up testing of certified Master Teachers of Mathematics to maintain that certification and the higher compensation and benefits associated with that stature.

Recommendations for Promoting the People Element

CUSTOMIZED TRAINING

Missouri's successful customized training program should be expanded to increase the size of a well-trained workforce that is a major draw in today's economy. Besides continuing to rely on Missouri's reputation as a hard working workforce, the state must also have a sufficient numbers of highly skilled personnel to move ahead of its competition. The university system and state colleges and universities should be allowed to participate as full partners with the community colleges to deliver job development and training services to the three targeted industries. Presently there is no state law barring participation by state colleges and universities but political issues have prevented widespread involvement.

The state should expand opportunities for small and medium size firms requiring financial assistance for training by establishing training projects in the three targeted industries as a priority for Missouri's Customized Training Fund projects.

Cost – Double customized training funding from \$15 million in 2001 to \$30 million in 2002.

TECHNICIAN TRAINING

Dedicate a portion of workforce training funds for life science technician training programs.

Cost - \$5 million annually

A technical workforce plan would address increased funding for programs within the state supported universities and community colleges which enhance the preparation of graduates for a technologically based economy. The Technological Workforce Plan should reward the preparation of scientists, engineers, computer scientists, and mathematicians and provide basic science, mathematics, and computer science education for all university graduates.

Cost - could reach \$30,000,000.

ONLINE TRAINING

To achieve this end the Coordinating Board for Higher Education will work with the Department of Economic Development, State Board of Education, and other departments of state government, and their respective staff to:

- Increase the proportion of working adults engaged in online postsecondary education courses, degree and non-degree education and training programs;
- Increase the number of online, internet-based courses targeted to working adults available through the Missouri Learners' Network (MLN)

Cost - To be determined

TAX CREDIT FOR INDIVIDUALS

Provide tax incentives to individuals who pursue education or training in any of the three target industries.

Cost - to be determined.

TAX CREDIT TO COMPANIES FOR TRAINING OPPORTUNITIES

Provide tax incentives to companies who pay for continuing education of workers in the three targeted industries. This can be in the form of tax credits (\$10,000 per employee) or tax deductions.

Cost - to be determined.

STUDENT AID

Offer grants or other student aid specifically targeted to the three target industries.

Cost - To be determined

Continue to promote and advance the state's Advantage Missouri Program to provide financial assistance to students preparing to work in biomedical/biotechnology, advanced manufacturing, and computer-related occupations in Missouri businesses and industries.

Cost - To be determined

Increase the Coordinating Board's funding recommendations for the Barnett Memorial Scholarship Program for part-time working adult students.

Cost - To be determined

MASTER TEACHERS OF MATHEMATICS

This program is designed to increase the math and science skills of Missouri citizens by improving education at the age levels that build a strong foundation for a technology-skilled workforce. Because the most dramatic decrease in mathematics skills is noted between the 4th and 8th grades, initial efforts will focus on improving teacher quality in middle schools. The proposed program will focus on improving mathematics teaching in an entire school through the development of master teachers who can mentor and consult with other teachers in their districts and regions.

Evidence of strength in mathematics will be based on national standardized examinations.

- To increase the number of Missouri's students graduating with mathematics degrees. Evidence of increased rate of graduation of mathematics majors.
- To attract and retain Missouri mathematics graduates in Missouri businesses. Evidence of success will be based on surveys of employers and the number of workers employed in those classifications requiring skills in mathematics.
- To increase and maintain the number of qualified Missouri mathematics teachers. Evidence will be follow-up testing of certified Master Teachers of Mathematics to maintain that certification and the higher compensation and benefits associated with that stature.

This program contains three elements: assessment, instruction and compensation.

Assessment

- The Missouri Technology Corporation (MTC) will offer school districts the opportunity to receive free, independent assessments of their mathematics programs.

Instruction

- If problems are discovered, MTC will submit a proposal to correct these problems and improve the mathematics programs and student performance in the district.

Compensation

- If the school board agrees with the proposal, it will pay for MTC consultants to help improve the mathematics instruction.

Over the next eight years, a two-part training program will be offered to middle school teachers. Upon completion of the training they will be certified as Master Teachers of Mathematics. The two-part training program consists of an initial four-week Mathematics Boot Camp and a subsequent four-week Mathematics War College. These intensive sessions will be conducted on Fort Leonard Wood, and combined with physical exercise. Some instruction will be available through the Internet to reduce the amount of time necessary to travel to Fort Leonard Wood.

This program will be instituted in the following phases.

- Train an initial core group of 40 master teachers, selected on the merits of their past accomplishments and recognition for excellence in teaching mathematics.
- These charter master teachers will design the curriculums for the Mathematics Boot Camp and War College and be available for hire to teach these sessions.
- Nine of these charter master teachers will be hired as full-time mathematics consultants operating out of the nine regional professional development centers
- The remainder will be paid stipends to act as consultants within their school districts and surrounding regions.
- As teachers graduate from the Mathematics Boot Camp and War College, they will receive recognition as Master Teachers of Mathematics and become eligible to receive pay stipends in

exchange for consulting or instructing other teachers in the Boot Camp/War College or follow-up sessions throughout the school year.

- Participating industries will provide funding for fellowships to supplement the salaries of certified Master Teachers.
- Boot Camp/War College courses will qualify for continuing education credits built into local salary schedules and maintenance of teaching certificates.
- Master Teachers will receive payment for hire as regional consultants and special session instructors.
- Master Teachers will have opportunities for summer employment with participating companies.
- Publicized recognition of those who achieve Master Teacher of Mathematics certification.
- All those certified as Master Teachers of Mathematics can receive:
 - ✓ Tickets to sporting and cultural events
 - ✓ Cash bonus for certification
 - ✓ Assistance in preparing tax returns
 - ✓ Airline tickets
 - ✓ Computers
 - ✓ Access to mathematics educational software.

Cost -\$5 million. Mathematics, Science, and Technology Foundation will be established by the partnering state government departments, and will be housed within the Missouri Technology Corporation to provide funding for the Mathematics Boot Camp and War College. The Departments will also approach educational and entrepreneurial foundations to solicit support for the Master Teachers of Mathematics initiative.

One hundred fifty Missouri companies will be asked to commit to sponsoring a teacher in school districts adjacent to their locations. Forty companies will be solicited to sponsor the Master Teachers of Mathematics who will provide instruction at the Boot Camp and War College. Initial contacts have been made with Ft. Leonard Wood to provide meals and housing for both the Mathematics Boot Camp and War College.

Money

This section stresses that a company in any of the three technology targeted industries will fail unless it has access to adequate funding. The current state of funding availability in Missouri is also analyzed. The duty of state government is to provide an environment that is friendly to investors and increases opportunities for companies to gain access to capital. There is a variety of avenues Missouri must explore to find novel ways to support growth in this area.

Technology Funding

Money is the lifeline of any successful business. A promising business can have a great product and a good management team, but if it does not have adequate growth capital the business will surely fail. The key is knowing where and how to access the money. There are several sources of money that an entrepreneur can tap into including banks, angel investors, professionally-managed venture capital firms, state/federal financing programs, and friends and family members. Normally when an entrepreneur starts a business they will rely on the bank (backed by the entrepreneur's personal collateral) or friends and family for their start-up capital. However, there comes a point when the new enterprise needs additional risk capital in amounts that surpass what is available from the previously mentioned sources. At this time it is imperative that the entrepreneur win the backing of angel investors or a professional venture capital company willing to take a risk in the business. There are also several state and federal programs that may offer a short-term fix or an incentive to attract investors.

There is a narrow "window of opportunity" for high technology firms to research, develop and market their technologies because of the tremendous amount of competition in these areas. They must be prepared for market demands; therefore, large expenditures of capital are made, sometimes months before any revenues come into the business. Because of this uncertainty of revenues, technology-based businesses are considered "high-risk" and cannot normally obtain conventional financing and must rely on equity capital rather than debt-based financing. Equity-based investments allow the investors the opportunity to obtain a greater financial return in proportion to the perceived greater risk of the venture. Furthermore, emerging technology firms usually do not have an asset base to secure debt financing. These "venture" capital investors are willing to take on a higher risk of investing to get a greater return on their investment.

Access to Venture Capital

The state of Missouri has made the decision to focus on several key industries in Missouri, including Life Science, Information Technology and Advanced Manufacturing of Transportation Equipment. These industries, on a national and international basis, have experienced and will continue to experience rapid growth. However, individual high-tech enterprises emerging from these industries are dependent on substantial amounts of venture capital to survive and thrive. Thus, the specific regions of our country that can expect to share in the bounty created by these dynamic industries will be those that offer their high-tech entrepreneurs a steady and dependable source of professional venture capital.

While Missouri has made important strides in creating a venture capital industry in recent years, it remains inadequate to permit Missouri to fully develop its high-tech economy. It is mandatory that the State of Missouri be attentive to this situation and that it act strategically in the years to come to help stimulate the development of a complete venture capital infrastructure in Missouri

On a national level, venture capital investing has taken a huge leap in 2000, as compared to 1999, with \$54.34 billion being invested in 4,130 companies from January through September 2000, as reported by

the PricewaterhouseCooper's *Money Tree Report* (PWC *Money Tree*). When compared to 1999 numbers of \$35.6 billion in 4,006 companies, it would seem the venture capital market has no need for worry. According to the National Venture Capital Association (NVCA) and Venture Economics Information Services (VEIS), venture capital investments "increased 96% in the second quarter of 2000 to \$24.5 billion" in the U. S." This is almost twice what was raised in the same period for 1999 of \$12.5 billion. NVCA and VEIS report that "despite months of market volatility, venture capitalists continued to invest in innovative, young companies at record levels." While the report indicates most of the investments made during the second quarter in 2000 were similar to investments made in the first quarter of 2000 in regards to type and location of companies receiving investments; the percentage of E-commerce investment followed market trends and decreased "by approximately 44%." This indicates that in recent months the interest in other technologies has shifted to industries that will "help move the new economy to the next level," such as communication infrastructure, computer software and services, and biotechnology/life sciences.

As reported by VEIS, the trends in the upcoming months reflect that more communications infrastructure-type companies will "continue to grow as the need to expand bandwidth and improve infrastructure rapidly increases." Even though investors have become wary of technology stocks in the last few months, "Turmoil in the NASDAQ has had just a minor ripple effect in the venture capital market" as quoted from Tracy Lefteroff, managing partner of PricewaterhouseCoopers' venture capital practice.

As the information technology market has cooled, venture capitalists have tweaked their investing strategies to the changing conditions, investing more in communication infrastructure companies and biotechnology/medical devices. This switch is also true in Missouri, where many of the investments in Missouri occurred in the communication infrastructure companies, including Celox Networks, Gabriel Communications and Partner Communications.

Venture Capital in Missouri

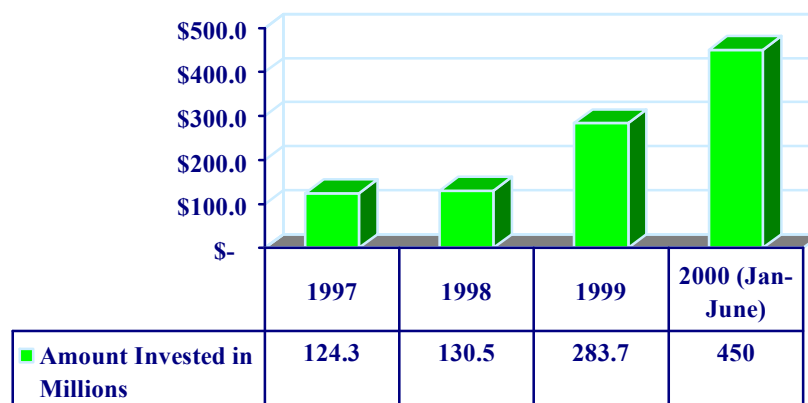
According to several sources, including TEQ Development in St. Louis, venture capital investments were not formally tracked in Missouri until 1997, so very little data exists prior to this time. Only two Missouri venture capital funds existed in 1995 and they did not look at technology deals. Missouri was a significant importer of venture capital, and received most of the investments from out of state firms. Missouri's number of dollars of new venture capital investment has followed the national trend by showing a steady upward movement from 1997 through 1999 and then an explosion of investments through the second quarter of 2000.

Since 1997, Missouri has gradually increased their venture capital investments and in 1999 set a record with \$283.7 million invested in 20 companies as reported by the PWC *Money Tree*. Also, in 1999, Missouri ranked 20th in the nation for disbursements of venture capital and second to Illinois in the six-state Midwest region according to VEIS. Almost 82 percent of this money was invested by outside venture funds.

According to the latest PWC *Money Tree*, venture capitalists invested approximately \$451 million in 28 Missouri deals during the first three quarters of 2000. This figure eclipses the previous record for Missouri set in 1999; even as venture capital investment activity in Missouri decreased substantially in the third quarter of 2000. As reported in the *St. Louis Business Journal*, the numbers can be deceiving. According to one official with a St. Louis venture capital firm, "It is very typical for a company to close a deal for \$50 million in one quarter, which leaves the impression that investments are going up, and then in the next quarter a big deal may not go through in time to make the next quarters report." Therefore, you really need to look at the entire year's investments to see the big picture of venture capital investing and not on a quarter-by-quarter basis. Also, the investments reported by VEIS and the PWC *Money Tree* are only as good as what the venture capital firms want or are willing to report; therefore, the reports more

than likely do not truly depict the investments that are being done. As a matter of fact, as reported by TEQ Development, several large investments were not reported in the third quarter figures of the PWC *Money Tree* report. Currently, however, these reports are the best available device for the State to obtain an accurate account of venture capital investing in Missouri.

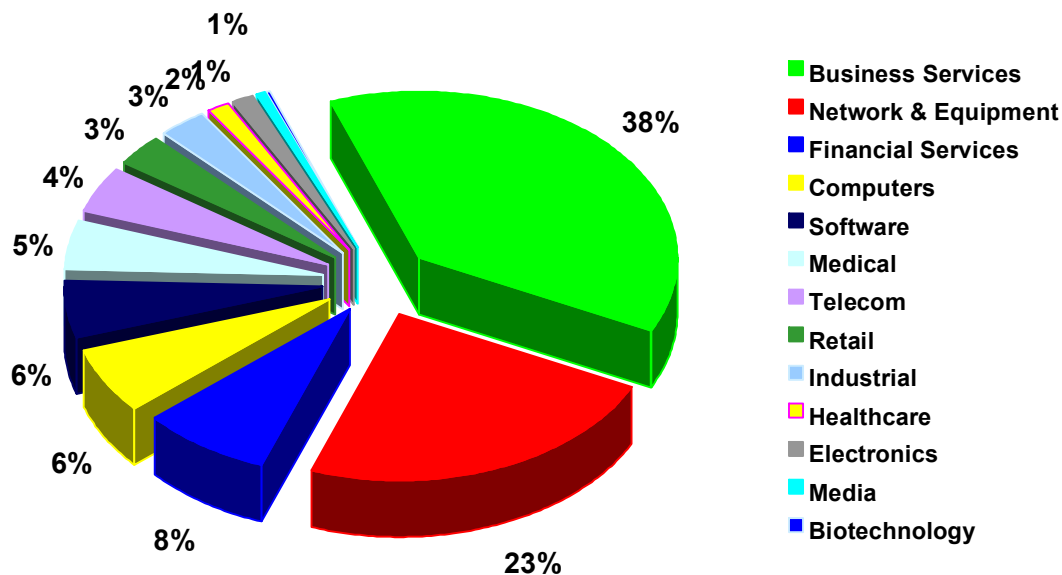
Year	# of Deals	Venture Capital Investments
1997	Not available	\$124.3 million
1998	Not available	\$130.5 million
1999	20	\$283.7 million
2000	28	\$451.0 million (Q1=\$138 mil) (Q2=\$312 mil) (Q3-\$1 mil)



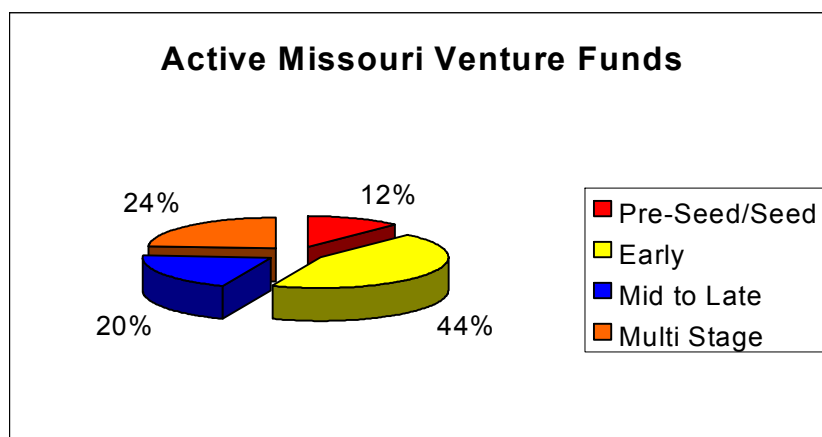
Venture Capital Invested in Missouri

Angel investors have and continue to be another source of risk capital. Missouri has seen a dramatic increase in the number of angel investors and organized angel groups over the past 5 years. The St. Louis Angel group now has 50 members. Both Kansas City and Springfield each have an active Angel investor network, but because of the turndown in the market the number of angel investments has decreased over the last few months.

Over the past 12 months, 38% of these investments have been in business service, 23% in network and equipment, 8% in financial services, 6% in computers, 6% in software, and 5% in medical. The balance was split between telecommunications, retail, industrial, healthcare, electronics and media. Nationally, the two largest investment areas are software and telecommunications, so Missouri is following the national trends.

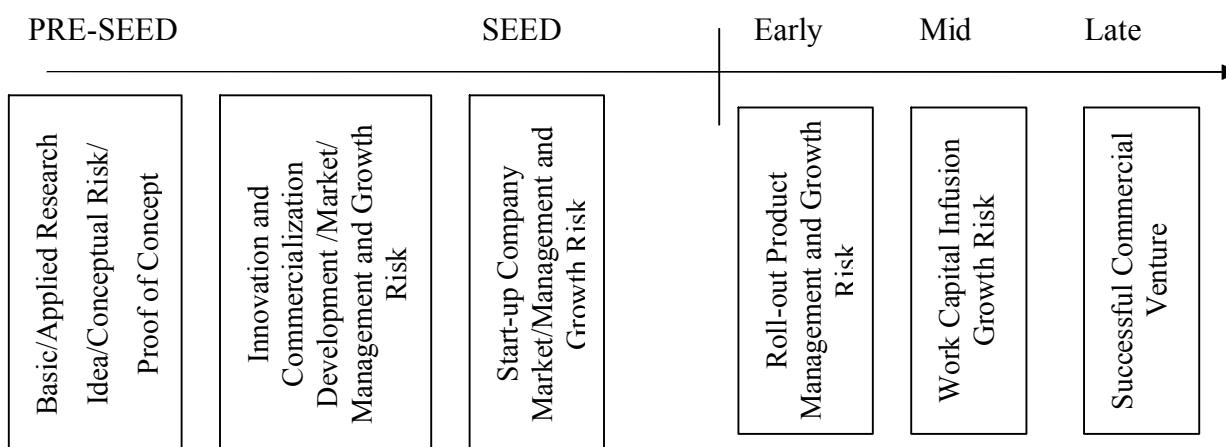


The department recently took an inventory of the venture capital funds in Missouri and has determined that currently 38 funds exist in Missouri and the Kansas City metro area. These 38 funds are being managed by approximately 60 professional fund managers. The total amount of venture capital for these funds is \$1.55 billion. Of the 38 total funds, 8 are actively investing; 10 are new funds currently being raised; 12 are fully investing and no longer active, except for follow-on investments; and there were 8 funds where information on the status of the fund was unavailable. Eleven were designated as “early stage” funds with approximately \$600 million in total capital which is either being raised or invested. Only three funds focused on the pre-seed/seed-stage companies for an estimate of \$90 million.



Even though Missouri's future regarding venture capital has looked much brighter over the last few years, the department must take steps to ensure Missouri as a state where venture capital funding is readily available. The Department recently surveyed 32 venture capitalist experts in Missouri and the metro Kansas City area. Of the 32 surveyed, eleven (34%) responses were received. Given the urgency and timing of the survey, this response was considered very good.

According to the responses, seed and early-stage capital is the most urgent need of emerging Missouri companies. Later stage financing is not as critical of a concern, since that gap is primarily filled by out-of-state investors. Most of the deal flow in Missouri happens in the pre-seed and seed stage, during which time the research and development of product is occurring and a start-up company is formed. Approximately 12% of the active funds are pre-seed or seed. Missouri must enhance the volume and quality of deal flow in the State. If the quality of deal flow available to venture capitalists is enhanced, the venture capital community will grow and thrive.



State government should assist by creating programs to target seed and early stage investing which focus on the key industries, i.e., life science, information technology and advanced manufacturing/transportation. It was also felt that the goal could not be obtained overnight. It would require a concerted effort on the part of the state government and private industry working together over the next 5 to 10 years. As venture capital sources continue to grow and raise funds, they will gain the size and the flexibility to "serve all stages and spaces."

A Venture Capital Roundtable was formed from the Governor's Roundtable on Venture Capital held in August 1999. The committee currently has 34 members from around the State, including venture capitalists, university leaders, incubator/innovation center directors, and several Chamber of Commerce members.

Missouri State Government Technology Funding Programs

Several state government programs have been implemented to provide incentives to angel investors or to encourage risky venture investments in seed and early-stage emerging technology businesses. A brief description and activity of these programs is listed below.

The Small Business Incubator Tax Credit program began in 1989 and was created to offer a 50% tax credit to any person or company who makes a donation to an approved incubator fund. The incubator would use the proceeds of the donations to make improvements to the incubator facility, which fosters growth and development of an emerging small business. The state currently has 11 approved incubators, four of which have used the program in the last two years. As stated by one incubator director, "The

incubator has attracted individuals from out-of-town to start their company in St. Louis, because of its location near the Washington University Medical Center, space designed for companies doing R&D on new technology products, and the extensive services the Center provides.” Other comments about the importance of incubators in the state include, “The incubators have been absolutely tremendous to early stage entrepreneurs and to the business community. We need to support the ones in existence and help them grow.”

The Small Business Investment Capital Tax Credit program was passed by the Missouri legislature in 1993 and began operating in January 1994. The purpose of the program was to be an incentive for private investment, normally angel investing, into small, emerging businesses in the State. For their investment, the investor would receive a 30%, and later a 40%, tax credit for which they could lower the amount of Missouri income taxes being paid to the State. At first the \$5 million program had minimal use, however, in 1997 because of an increased marketing effort by the department, the program gained in popularity and in June 1998 the tax credits were depleted.

In 1999 the program was authorized an additional \$8 million in tax credits. Two tax credit percentages were approved, giving an investor either a 40% tax credit or a 60% tax credit if the business was located in a “distressed community.” The program only lasted seven months, and in July 1999 all of the tax credits were exhausted. One hundred and twenty-seven companies were approved to use the program, of which 76 received investments.

The Certified Capital Companies (CAPCO) program was passed by the Missouri legislature in 1997 and authorized Missouri as the second state to utilize this type of vehicle to spur venture capital investments. The purpose of the program is to offer 100% tax credits to insurance companies to invest in a private venture capital firm, or CAPCO. The CAPCO must abide by certain regulations and invest the capital in emerging businesses headquartered in the state. The program was eventually approved at \$140 million in tax credits. To date, there are six approved CAPCOs who have invested \$60 million in 28 small businesses. The small businesses consist mainly of information technology and telecommunication-type businesses.

The New Enterprise Creation Tax Credit program was approved by the Missouri legislature in 1999. This program authorized \$20 million in tax credits to be given at 100% to investors in the New Enterprise “seed” fund. The fund is to be managed by a professional fund manager and overseen by a thirteen-member board, of which eight of the members are approved by the Governor and confirmed by the Senate. The board has made great progress over the last six months, approving Prolog Ventures, LP as the fund manager and approving the Limited Partnership agreements on December 5, 2000. Currently, Prolog hopes to close the first round of funding in late December 2000 and the second and final round of funding in March 2001. The focus of the fund will be life science and information technology emerging businesses. The board has required that the \$20 million in tax credits be leveraged by no less than 2:1.

The Qualified Research Expense Tax Credit program was approved by the Missouri legislature in 1993 and began operation in January 1994. This program, based on the federal Research tax credit, gives any company which has conducted research in the past three years on a new product or service in Missouri a 6.5% tax credit based on the current years research minus the average research of the previous three years. On average 70 companies utilize this program each year. In 1999, a cap of \$10 million was put on the program; however, during the 2000 legislative session additional changes were made, including lowering the cap to \$9.7 million. It made the tax credit transferable for research conducted in 2001. Most of the businesses utilizing this program are large and at a later financing stage, and not an emerging businesses.

Missouri Comparison to Other States

We can look to other states that have successful seed and venture capital programs for possible innovative solutions. We must be aware that other states throughout the country are intensifying their technology and venture capital strategies as they compete for their share of the New Economy. In preparing this report we researched four neighboring states— Kansas, Oklahoma, Illinois and Kentucky.

The Kansas Technology Enterprise Corporation (KTEC), a quasi-public corporation was established by the State of Kansas in 1987 to promote advanced technology economic development. Their mission is to foster technological innovation and the creation, growth and expansion of Kansas enterprises. KTEC is governed by a 20-member board of directors and funded by the State with proceeds from the Kansas Lottery and gaming commission. With an annual budget of \$13 million, KTEC has helped create professionally-managed pre-seed, seed and venture funds in Kansas, establish programs that offer commercialization grants to technology innovators in Kansas universities and elsewhere, and to provide key funds and support to increase Kansas's participation in the federal Small Business Innovation Research (SBIR) program, a key source of pre-seed and seed capital for innovators.

The Oklahoma Capital Investment Board (OCIB) was created to mobilize equity and near-equity capital for investment in such a manner that will result in a significant potential to create jobs and diversity and stabilize the state's economy. Oklahoma established this state beneficiary public trust approximately five years ago. The Oklahoma Legislature initially approved \$50 million in tax credits to OCIB. OCIB then contracted with local utility companies to buy the tax credits, if problems occurred with the investments from the fund. The utility company guarantee is used by OCIB to leverage and borrow money from a private lender at a very attractive interest rate (around 7 percent). This borrowed money is then invested in professionally-managed venture funds across the nation, whereby OCIB looks for a 15% rate of return. This return is then used to pay back the lender and other fees associated with the program. A good portion comes back to the state. The focus of the investments is on early stage start-ups to later stage expansions and the venture funds are able to invest in deals all over the world.

Since the inception of the program, OCIB has never had to utilize the tax credits; therefore the program has cost the state of Oklahoma nothing in terms of a negative impact on the state budget. The OCIB requires that venture funds in which they invest establish an Oklahoma presence making capital and the expertise of professional venture capitalists more easily accessible to Oklahoma entrepreneurs. Many Oklahoma companies have received investments and millions of dollars in program "profits" have come to Oklahoma as a result of both investment dollars and income earned by funded companies. During the last legislative session, the General Assembly evaluated the program and authorized an additional \$50 million for the program.

The Kentucky Innovation Act was signed into law by the Governor of Kentucky in April of 2000. It is a \$55 million package designed to capitalize the Commonwealth's transformation into a knowledge-based economy. The Act offers a wide variety of opportunities to both public institutions and private entrepreneurs and investors. In October 2000, Lexington, Kentucky's first venture capital fund was created, raising \$50 million.

The Illinois Technology Enterprise Corporation (ITEC) was a concept developed by the Illinois Coalition in 1998. It provides a statewide system of regional, entrepreneurial development centers. Since 1989, the Illinois Coalition has been the catalyst for strengthening Illinois' economy through science and technology. Governor Ryan recognized the necessity of having this network and made ITEC his cornerstone of the Illinois VentureTECH agenda, with funding of \$1 million last fiscal year and \$2 million in FY2001. The Governor announced in February 2000 his proposed plan of \$1.9 billion investment for Illinois VentureTECH, which will help ensure Illinois' place at the forefront of the new high-tech global economy. VentureTECH will invest the money over the next five years in advanced

research and development, health sciences, information technology and biotechnology. In addition, the plan calls for an \$800 million investment in venture capital funds over the next three years to support high-tech startup firms in Illinois. To accomplish this goal, Governor Ryan has secured the cooperation of the State Treasurer, the Board of Investment, the Development Finance Authority and each of the major pension boards in the State.

In comparison to other Midwest states Missouri has, in recent years, been able to keep pace. Nationwide, however, the competition between states is growing. Missouri must develop and implement an aggressive strategy to ensure that we are successful in building our technology economy. Missouri should look to other states to see what programs have been successful such as the KTEC SBIR program and the OCIB program and use them to guide us in our goal of creating a “dynamic and vibrant” venture capital community.

Goal

The goal for the State of Missouri, as it relates to venture capital, is to “build a dynamic and vibrant venture capital community serving all stages and spaces.” While this goal may be aggressive, it is not unattainable. A majority of the Venture Capital Roundtable members who responded to the survey, felt the goal was realistic, but that it needed to be solved through a planned, step-by-step process. State government should assist by creating programs to target seed and early stage investing which focus on the key industries, i.e., life science, information technology and advanced manufacturing/transportation. It was also felt that the goal could not be obtained overnight. It would require a concerted effort on the part of the state government and private industry working together over the next 5 to 10 years. As venture capital sources continue to grow and raise funds, they will gain the size and the flexibility to “serve all stages and spaces.”

Recommendations for Promoting the Money Element

RESEARCH AND DEVELOPMENT TAX CREDIT

Restructure the existing research and development tax credit program to increase the current six and one-half maximum percentage claim of qualified research expenses incurred to fifteen percent. In addition, add a \$5 million annual increase to the current program.

Cost -- \$15 million annually.

In an effort to allow participation by startup companies, allow the qualified research expense tax credits to be transferred or sold.

Cost - To be determined

TAX EXEMPTIONS

Treat research and development revenue as non-taxable income.

Cost - to be determined.

Exempt capital expenditures for research equipment used in laboratories from sales, use, and real property taxes. Could be limited to small companies, under 150 employees.

Cost - To be determined

EQUIPMENT TAX CREDIT

In order to provide incentives to industry to replace older production equipment and replace it with new technology equipment, tax credits should be offered. This older technology equipment does have use, however, for firms that may not need the latest in technology. An independent non-profit organization

could take possession of this older technology equipment to lease at a reasonable price to those firms not requiring newer technology production equipment, especially firms starting up as incubator clients.

Cost -- \$15 million in tax credit incentives to replace old equipment with new.

Also, a \$2 million tax credit should be authorized to encourage donations of productive used equipment to the non-profit organization for lease to other Missouri small businesses.

Cost - \$2 million

CAPITAL TAX CREDIT PROGRAM

The department tried last year to renew funding for this program, but failed at the final hour. This program has much support from the business and investment community and also many members of the General Assembly. It provides an extra incentive to potential angel investors needed by many small businesses to attract investors. According to several sources, the number of angel investors in the State is growing, but the lack of the Capital Tax Credit program has caused many of them to sit on the sidelines and not invest. This may also be due to the downturn of the market. The tax credits help offset the perceived risk, therefore the angels are more willing to invest. The Roundtable proposes to lower the tax credit percentages to 30% and 50%, instead of the current 40% and 60% to make the credits last longer, while still providing a good initial return to the investor.

They also propose to cap the program at no less than \$5 million and to automatically renew the tax credits annually, so that investors know the credits will be available each year. Another significant change would be to revise the language to avoid recapture of tax credits from good faith third party purchasers. Other revisions have been proposed, such as, limiting the program to only technology-based and manufacturing companies and changing the period that the investment must remain in the business from 5 to 3 years, unless the company is sold, has a change in control or goes public. Another suggestion was to make the approval of the companies participation in the program contingent upon attending a “venture capital” workshop designed for entrepreneurs.

Cost -- \$5 million tax credits annually. \$200,000 to innovation centers to conduct workshops.

SEED CAPITAL TAX CREDIT

Resurrect the Seed Capital Tax Credit program and limit its use to life science, information technology, or transportation manufacturing enterprises. Make it a 60% tax credit. The unused portion of this and other tax credit programs can be added to this program fund, which can be allowed to grow if it is not completely used in any particular year.

Cost -- \$5 million annually.

PRE-SEED FUND

Create a pre-seed fund that can be used to help companies with proof-of-concept or prototype development. This fund could also be used to pay for assisting companies with development of business plans, proposals, and strategies to successfully gain venture capital investment. The innovation centers should be the resource centers for this assistance.

Cost - \$2.1 million per year.

SEED CAPITAL INVESTMENT BOARD

One of the components of this strategy refers to the New Enterprise Creation Act and the seed fund that is currently being raised by Prolog Ventures. The Roundtable will continue to support the fund manager and the Seed Capital Investment Board on an as needed basis, as they conclude their fund raising efforts and begin to look for companies in which to invest.

Cost – No additional.

348 SEED CAPITAL PROGRAM

Renew the 348 Seed Capital program place it under the control of the Missouri Seed Capital Investment Board. They also propose to limit the use of the credits to the creation of a series of small pre-seed funds that will primarily focus on commercializing promising technologies out of our universities and other research laboratories.

Cost -- \$5 million annually.

SBIR AWARDS PROGRAM

Develop three programs, administered by MOST, to help small companies and researchers compete for federal SBIR awards, and:

- The first program is the Phase 0 SBIR Program which funds small businesses, university researchers, graduate students, and others conducting preliminary research for an SBIR proposal.
- The SBIR Proposal Preparation Grant Program is the second program that assists small businesses in obtaining federal SBIR awards by providing grants of up to \$5,000 to support SBIR proposal preparation.
- The third SBIR program is the Bridge Funding program that provides low interest loans to Missouri companies that have won Phase I awards and are applying for Phase II awards. Companies selected for bridge funding can receive up to \$50,000 to help them meet operating expenses during this critical period between awards.

Cost - \$500,000 annually

CAPCO PROGRAM

Continue to support the CAPCO program at its current funding level. Fifty-five percent of the surveyed members of the Venture Capital Roundtable (55%) said they believed the CAPCO program directly accounted for the increase in venture capital investing since 1997, i.e., the program “jump-started” the venture capital community. The CAPCOs state that they have partnered their portfolio companies with institutional investors committed to their growth. The job growth and follow-on investment achieved by these companies is a testament to the certification effect a business can enjoy after receiving a venture investment and the benefits of partnership with a venture firm.

While some members of the Roundtable propose an increase in tax credits for the CAPCO program, the department should remain neutral on this program. It is thought by many in the venture capital community that the CAPCOs should now be able to raise private funds without the support of continued tax credits, of which they received \$140 million over a three-year period. If additional tax credit funding is obtained through legislation, the State should work with the CAPCOs to provide a plan over the next three to five years to outline the continuation of the CAPCOs without support of future tax credits.

OCIB PROGRAM ALTERNATIVE

One alternative to the CAPCO program is to utilize a portion of the tobacco settlement money to provide direct funding into private venture funds or to use as a match for seed funds or for pre-seed and commercialization activities. Missouri could also look to the Oklahoma model as a way to help expand Missouri’s venture capital infrastructure while minimizing the cost to the State. The OCIB program has been successfully operating for more than five years and has yet to cost the state of Oklahoma anything to operate.

Cost -- If the CAPCO program is renewed at the level proposed during last year’s legislative session, the state can expect an increase in tax credits of \$50 million. Therefore, the estimated cost to the State and the impact on Total State Revenue would be an additional \$5 million per year for ten years. The OCIB program would cost the State approximately the same as a renewal of the CAPCO program; however, the tax credits would be used to secure a loan guarantee and may not need to be utilized if the program is

successful. Again, the credits would then only impact Total State Revenue, if they are redeemed against income tax.

WEB SITE

Create and co-host a venture capital web site to provide general information to educate entrepreneurs and angel investors about the realities of raising equity and investing in high-risk companies. The web site would also be used to report investment activity in Missouri, publicize success stories, and provide a network of venture capitalists, angel investors and entrepreneurs to link them together. The web site would include articles from and interviews with leading venture capitalists across the state and the nation.

Cost -- \$50,000 annually.

TOBACCO FUNDING

Place tobacco settlement funding on the Fall 2001 ballot. Dedicate portion of money to fund life sciences initiatives undertaken by universities, community development organizations, or federal agencies. MOST could judge the merits of the proposals.

Cost - \$1.2 billion

TECHNOLOGY FINANCING AUTHORITY

Create a technology financing authority similar to the Missouri Development Finance Board. This could be a central office, like MDFB, or structured like the Tax Increment Financing legislation that allows these authorities to be created where ever a program can be feasibly created.

Cost - depends on whether TIF funding model or MDFB funding model is used.

Speed

This section stresses that in order for technology developed in universities to be of value to society, it must be quickly and efficiently transferred and applied in the marketplace. There have been too many missed opportunities in the past because of a lack of environment to support such activity. State government can generate and coordinate opportunities and incentives for researchers to interact and partner with industry.

University Technology Development and Commercialization

The university plays a critical role in the deployment of technology in the businesses of a state. It is extremely unlikely that any state or country will become a significant site of technology based businesses without a strong research university. The university can supply the pool of educated personnel, the research and development required to further the technology, and the fundamental understanding of the applicable technology. Without the creative force of the University, a state will at best be a source of low cost labor for mature technologies.

The state of Missouri has strong research universities. However, the research in these universities is not as well funded as the research in many universities in other states. In all universities the research is funded based on competitive research proposals. The economic impact of the research is at most a minor factor in the evaluation of research proposals by the granting agencies. While it is difficult to predict where the next technological breakthrough will arise, it is possible to estimate probabilities of economic potential. It is in the state's interest to increase both the level of research support in the universities in Missouri and the focus of that research on technologies with potential economic impact.

Challenges

The reward system for faculty members does not provide a strong incentive to become involved in business. The faculty undertakes research for their own enlightenment and is rewarded by the professional recognition of their colleagues. While faculty has some financial interest in the economic impact of their research, the commitment of the time and energy required to promote technology transfer detracts from efforts with more direct impact on their professional success. Because the faculty's professional recognition is national in scope, faculty members who are involved in research with industrial applications tend to have a national focus rather than a Missouri focus. The faculty is aware of the research of their peers and employ those results in their own research, but do not usually connect the research results to the needs of Missouri industry. A process needs to be developed which will provide effective incentives for the university faculty who are willing to inform the entrepreneurs within the businesses community about new technological developments. Not only must we increase the amount of research conducted by Missouri universities, but we must also increase the amount of technology transferred from Missouri universities.

Goals

- Increase the amount of research conducted by Missouri universities.
- Increase the amount of technology transferred from Missouri universities.

Recommendations for Promoting the Speed Element

TECHNOLOGY TRANSFER TAX CREDIT

Create a tax credit to establish a university applied research program administered by the Missouri Technology Corporation. The purpose of the program will be to promote research process/product development collaboration between small and medium-sized Missouri businesses and research universities for the benefit of the three targeted industries. The university system and state colleges and universities must establish cross-functional, integrated centers to support transportation equipment advanced manufacturing within the state with industry advisory boards to ascertain the technology trends within their industry segment. The state and university programs must encourage, even demand, collaborative research and development (R&D) among industry, federal laboratories, the National Science Foundation and Department of Commerce Advanced Technology Program (ATP) and other research institutions to expand the commitment of private industry to longer-term, higher risk R&D.

Cost -- \$5 million in annual tax credit incentives to promote collaboration and commercialization.

DOD LIAISON OFFICE IN WASHINGTON D.C.

The last focus of this objective is to encourage Missouri's research universities to explore opportunities to develop innovative Department of Defense IT training programs in partnership with Ft. Leonard Wood that could be commercially applicable. We should determine whether Missouri's Congressional delegation could be of assistance in identifying opportunities to further assist Ft. Leonard Wood in ways that would help to achieve Missouri's overall goals to improve commercial opportunities for training. This could be accomplished by a Washington D.C. liaison working for the state of Missouri. One form of assistance should be a study of potential opportunities in future DOD BRAC processes.

Cost - To be determined

FORT LEONARD WOOD LIAISON POSITION

This office would discover and develop joint research opportunities and attract increased DOD research dollars into Missouri. Costs would be shared on 1:1 basis with the university.

Cost -- \$40,000 per year to match university funding.

Summary of Recommendations for the Governor

The following is a compilation of specific recommended actions that can be accomplished by the State of Missouri to best develop technologies for the most far-reaching impact and creation of wealth for Missouri's citizens. The top ten recommendations are prioritized and listed at the end of this report.

Establish the Missouri Office of Science and Technology Within DED

- ❖ (Changed order) Create a research and development presence for Missouri on a national and global scale. Missouri should position itself to be a world-class leader in the new economy by creating a new Missouri Office of Science and Technology that would include the current Office of Productivity and its current technology programs and activities.
- ❖ The Missouri Office of Science and Technology should seek to increase Missouri's presence with federal agencies, and private funding sources by increasing the capacity of Missouri institutions of higher education, businesses, and nonprofit organizations to compete successfully for a larger share of federal or private research and development funding. To accomplish this mission The Missouri Office of Science and Technology would be responsible for hiring a permanent staff to promote Missouri's interests in the new economy.
- ❖ To create the Missouri Office of Science and Technology, it is recommended that an annual appropriation of general revenue in the amount of \$500,000 be appropriated for the office and executive staff. The staff should include an executive director and three professional positions. Each staff member would be designated to a specific industry cluster to develop and maintain relationships with companies within the assigned target cluster.
- ❖ It is recommended that the Missouri Department of Economic Development seek a one-time appropriation of \$250,000 for the Missouri Office of Science and Technology to fund three specific planning reports in each of the areas of concentration – life sciences, information technology and advanced manufacturing/transportation. It is intended that this funding be used to formulate an industry-driven technology assessment and strategic plan, as well as to determine a long-range economic development investment plan designed to strengthen Missouri's technological presence over the next four years.
- ❖ The Missouri Office of Science and Technology should partner with and support the Missouri Technology Corporation (MTC) to develop a strong presence in the new economy as a knowledge-based leader in the new economy and the liaison with the Department of Economic Development on behalf of the MTC.
- ❖ It is also recommended that appropriate funding be approved to cover operational costs of the Missouri Technology Corporation. The Missouri Technology Corporation was created to coordinate a statewide technology effort and appropriately advise the Governor and the Department of Economic Development on the direction of technology and policy recommendations. Cost -- \$200,000 annually.
- ❖ To develop and maintain funding relationships with public and private sources, it is recommended that the Missouri Department of Economic Development seek an appropriation of general revenue in the amount of \$250,000 for contractual services and expenses to conduct continuous funding activities in Washington D. C. This liaison activity would be responsible for increasing the total amount of Federal funding flowing to Missouri's research and development activities.
- ❖ Match annual university contribution to maintain UMR FLW liaison office to develop joint research projects with DOD at FLW. This match would equal \$40,000 per year.

Funding Requests	
Operational costs of MTC	\$200,000 annual
Establish the Missouri Office of Science and Technology	\$500,000 annual
Fund three planning reports.	\$250,000 one-time
Develop and maintain federal activities in Washington, D.C.	\$250,000 annual
Develop and maintain UMR/FLW liaison office	\$40,000 annual
Total Annual Request	\$840,000

Develop Initiatives for the Missouri Office of Science and Technology

- ❖ Reorganize the Centers for Advanced Technology (CAT) program with the Missouri Office of Science and Technology (MOST) managing the program and making funding decisions based on project merit. Funding could be awarded to projects or technology-specific centers. Emphasize more industry-initiated projects. Universities, though, should still refer projects. This would increase the geographic distribution of the program and broaden political support. Minimum annual cost for statewide program -- \$4.25 million. (\$130,000 for administrative costs and the rest to support approved projects.)
- ❖ Consolidate all NIST Manufacturing Extension Programs under one Missouri program administrator. This agency would coordinate assistance available to manufacturers through the MEP program, state-affiliated innovation centers, Small Business Development Centers, and funding programs. Cost – No additional costs due to overhead cost savings from consolidation.
- ❖ Establish the Research Alliance of Missouri (RAM) initiative. The first piece of the RAM initiative is the creation of an advisory board comprised of chief research officers from universities and institutions around the state to advise the Governor in the development of a research agenda to promote in Missouri and Washington, D.C.

We must ask how we can transform Missouri into a research magnet? How do we forge a statewide network that can increase research capacity in this area and make us more efficient and competitive? There are some examples of collaboration around the state and between public and private institutions that already exist, but there is no systemic coordinated approach to sustain these networks on an ongoing basis. The Research Alliance of Missouri Advisory Board will report to the Missouri Technology Corporation.

RAM also includes a network of experts to seek or “mine” information about new research and technologies in order to link research to commercial opportunities. This program will consist of several individuals located throughout Missouri who will work in cooperation with universities and corporations to find what technologies are being developed at research centers and universities around the state. Their job is to find and identify these promising technologies, and work to nurture the research to a point where it can attract financing for business development. Their primary responsibility will be to help transfer technology into a product and create new companies out of technology ideas within our universities and research institutions. “Miners” will be located in St. Louis, Kansas City, out-state Missouri, and one to focus on agriculture-related research. Cost -- \$500,000 annually.

- ❖ Appropriate remaining \$1 million in FY 2001 for development of the University of Missouri Technology Park at Fort Leonard Wood. The state of Missouri appropriated one million dollars for this project in FY 2000, with an understanding that there would be a follow-on \$1 million appropriation in FY 2001. This amount will be matched by the University of Missouri for a total of four million dollars available for development of this park. FY 2001 appropriation cost -- \$1 million.
- ❖ Appropriate \$5 million to establish an incubator at the University of Missouri-Columbia with businesses targeted that are developed as a result of the university's research nuclear reactor to take advantage of the UMC's unique position and ability to foster research and development. The nuclear reactor on the Columbia campus of the University of Missouri has made significant contributions to life sciences nationally and internationally. Within the near future, the University's reactor will be the only licensed, university-owned reactor in the country. Cost -- \$5 million one time.
- ❖ Maintain state support for existing state innovation centers and expand into Springfield and Cape Girardeau. Cost -- \$2 million annually at approximately \$440,000 per year per existing center.
- ❖ Establish a Governor's Telecommunications Roundtable comprised of the Public Service Commission, the Public Counsel, IT industry leaders, telecommunications providers (both large and small), economic development officials, academia, state and local elected representatives, and consumers. This group will collect the data and annually prepare a comprehensive Telecommunications Plan to help guide legislative and economic development programs.
- ❖ Establish the Missouri eBusiness Institute (MO-eBI) as a coalition between the NIST-Manufacturing Extension Partnership center in Missouri and the University of Missouri System eBusiness program. MO-eBI will serve as the focal center for project coordination and partnership building between manufacturers, education, communication and leading computer hardware, software, and service companies. A marketing plan would be coordinated with establishment of MO-eBI. Cost to Missouri: FY 2001- \$1,000,000; FY 2002 - \$750,000; FY 2003 - \$500,000; FY 2004 - \$500,000. Funds matched 1:1 from other non-state funding sources.
- ❖ Continue funding for Value-Added Agriculture Cooperative Assistance Program. Technology elements of this program include:
 - ◆ applying improved and advanced manufacturing processes to the Agriculture industry; and identifying, stimulating, and guiding the research and development of new technologies to give agriculture cooperatives the competitive means to process ag commodities into value-added products.
- ❖ Establish the Master Teachers of Mathematics Program.
Cost -- \$5 million to be funded by industrial sponsors and private foundations.

Funding Requests	
Reorganize CATS	\$3,309,468 annual*
Establish & Maintain RAM	\$250,000 annual
Develop Ft. Wood Park	\$1,000,000 one-time
UMC-Incubator	\$5,000,000 one-time
Expand Innovation Centers	\$1,025,360 annual*
Establish Masters In Math	\$5,000,000 private funding
Total Annual Request	\$4,584,828

*Denotes difference between current appropriation and new request

Increase Availability of Technology Funding

- ❖ Appropriate at least \$5 million a year for the Capital Tax Credit program with no specific set-aside for distressed communities. Allowing a 50% tax credit in distressed areas and 30% in non-distressed areas will create incentives for distressed communities and also provide a good return to investors.

There is a high possibility that life science clusters may not lend themselves to development in distressed communities. We recommend the following changes to Capital Tax Credit legislation.

- ◆ Limit Capital Tax Credits to technology-based and advanced manufacturing companies.
- ◆ Amend Capital Tax Credit legislation to reduce the minimum time an investment must remain in business from five to three years. That time frame is exempt if the company is sold, has a change of control, or goes public.
- ◆ Amend Capital Tax Credit legislation to avoid recapture of tax credits from good faith, third-party purchasers.
- ◆ Add Capital Tax Credit legislation that requires a facility to remain in the state for five years after receiving credits, or credits are refunded by current or purchasing company that moves the facility out of the state. Tax credit is transferable and third party purchasers who keep the company in the state would not be required to refund tax credits if operation remains in Missouri for the required period of time.
- ◆ Cost: \$5 million annually
- ❖ Create a \$5 million University Applied Research Tax Credit program to promote research and process/product development collaboration between small and medium-sized Missouri businesses and research universities for the benefit of the information technology, life science and advanced manufacturing/transportation industries. The program would be administered through the Missouri Technology Corporation. Cost: \$5 million annual.
- ❖ Continue to support the CAPCO program at its current funding level. It is recommended that a portion of the tobacco settlement money be used to provide direct monies into private venture funds or to use as a match for seed funds or pre-seed and commercialization activities. Missouri could also look at the Oklahoma model as a way to help expand Missouri's venture capital infrastructure while minimizing the cost to the State. Cost – Will vary depending on how it is operated.
- ❖ Fund venture capital forums and workshops for existing and potential businesses conducted by state-affiliated innovation centers. Cost -- \$200,000 annually.
- ❖ Sponsor Venture Capital Web Site. Cost -- \$85,000 annually.
- ❖ Establish the Governor's Venture Capital Roundtable as the primary advisors to the state of Missouri on all seed and venture capital investment strategies.
- ❖ Create a pre-seed fund that can be used to help companies with proof-of-concept or prototype development. This fund could also be used to pay for assisting companies with development of business plans, proposals, and strategies to successfully gain venture capital investment. The innovation centers should be the resource centers for this assistance. Cost: \$2.1 million annually.
- ❖ Renew the 348.300 Seed Capital Tax Credit program and place it under the control of the Seed Capital Investment Board. The program should be limited to use by life science, information technology, or transportation manufacturing enterprises. The tax credit amount should remain at 50% and the distressed community provision should be removed, due to the fact that technology clusters may not lend themselves to development in distressed communities. Total cost -- \$5 million annually.
- ❖ Provide tax credits for creating additional technology business incubators or expanding capacity of existing operations in life science cluster or potential cluster geographic areas. Total cost -- \$1.5 million one time.
- ❖ Fund grant and proposal writer positions within each of the state-affiliated innovation centers to help technology-based companies prepare winning SBIR/STTR and other government research funding proposals. Cost: \$270,000.

- ❖ Implement an “SBIR Stage 0” program that selects projects in Missouri with good SBIR potential and funds the preliminary research and support network necessary to prepare a winning proposal. Also establish an SBIR/STTR Bridge Funding loan to cover operating expenses between the period of time a firm completes a Phase I project and receives Phase II funding. Cost: \$750,000 annually.
- ❖ Create technology-financing authority similar to the Missouri Development Finance Board. This could be a central office, like MDFB, or structured like the Tax Increment Financing legislation that allows these authorities to be created wherever a program can be feasibly created. Costs depend on whether TIF funding model or MDFB funding model is used.
- ❖ Provide state grants and/or assist in obtaining federal grants to install cables, wires and equipment to accommodate broadband fiber and high-speed telecommunications equipment in facilities operated by state-affiliated innovation centers. Cost -- \$4 million.
- ❖ Provide tax credits to manufacturing companies who replace existing equipment with state-of-the-art production equipment and donate usable, used equipment to be redistributed to small businesses that can still use it to increase productivity. Cost -- \$15 million one time.
- ❖ Revise the current Qualified Research and Development tax credit program to allow participation by startup companies with a focus on young life science companies. The cap should be increased to \$15 million per year, with \$5 million per year allocated to startup, life science companies.
 - ◆ Maintain the existing research and development tax credit program, but cap large corporation participation at ten million dollars a year.
 - ◆ Maintain the transferable capability added in 2000.
 - ◆ Total cost -- \$5.3 million annual increase from current program.
- ❖ Treat research and development revenue as non-taxable income. Cost to be determined.
- ❖ Exempt capital expenditures for research equipment used in laboratories from sales, use, and real property taxes. Establish similar exemption for costs to purchase and install high-speed telecommunications equipment. Could be targeted at geographic life sciences clusters, if desired. Could also be limited to small companies, under 150 employees.

Funding Requests	
Renew Capital Tax Credit program	\$5,000,000 annual
Create University Applied Research Tax Credit program	\$5,000,000 annual
Support CAPCO program at current level.	TBD
Support Venture Capital workshops and forums	\$200,000 annual
Sponsor Venture Capital Web Site	\$85,000 annual
Create Pre-seed fund	\$2,100,000 annual
Renew Seed 348.300 Tax Credit program	\$5,000,000 annual
Create technology business incubators	\$1,500,000 one-time
Support SBIR/STTR research proposals	\$270,000 one-time
Support SBIR Stage 0 and SBIR Bridge Funding	\$750,000 annual
Create Technology Finance Authority	TBD
Provide grants for Broadband Network	\$4,000,000 one-time
Value-added Ag Program	TBD
Equipment Replacement Tax Credit	\$15,000,000 one-time

Revise current Qualified Research Tax Credit program	\$5,300,000 annual increase
R&D Non-taxable income	TBD
Research equipment exemption	TBD
Total Annual Request	\$23,435,000

OUTCOMES

ANNUAL FUNDING REQUESTS WHAT IS IMPACT OF FUNDING ON MISSOURI?		
REQUEST	ANNUAL AMOUNT SPENT	IMPACT
Establish Missouri Office of Science and Technology	\$840,000	\$60 million per year* in outside R&D funding.
Assist commercialization of projects/products	\$28,019,828	467 new projects**
Fort Leonard Wood Technology Park	\$1,000,000 General Revenue appropriation	20 new businesses; 750 – 950 jobs
Establish Masters in Math Program	\$5,000,000 private funding	10% increase per year in proficiency of 8 th grade students.
GRAND TOTAL	\$28,819,828***	

*Figure arrived from experience over the past three years by the University of Missouri system.

**Currently 30 projects are being developed each year under the CATS and Innovation Center programs funded annually at \$1.9 million.

***Grand total does not include Fort Wood or Masters in Math program.

Top 10 Prioritized Recommendations

1. Establish Missouri Office of Science and Technology (MOST) at cost of \$500,000/year. *(Completed)*
2. Appoint Missouri Technology Corporation to coordinate statewide effort and advise Governor. *(In Process)*
3. Establish Research Alliance of Missouri at cost of \$500,000/year.
4. Consolidate all NIST/MEP under MOST. *(Completed)*
5. Appropriate \$1 million for Fort Leonard Wood Business Park. *(Completed)*
6. Appropriate \$5 million to establish nuclear reactor incubator at UMC. *(In Process)*
7. Establish Master Teachers of Mathematics Program with industrial sponsors and private Foundations. *(In Process)*

8. Renew funding for Capital Tax Credit at least \$5 million per year.
9. Create \$5 million University Applied Research Tax Credit program.
10. Establish Venture Capital Roundtable as primary advisors to MTC. (*Completed*)